THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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Advertisements, new names and corrections to existing entries should be sent in at once.

TECHNICAL MEN AND THE WORKMEN'S COMPENSATION ACT.

A CASE of considerable importance to all technically trained men who are engaged as chemists, electricians, or engineers in factories or workshops came before the Court of Appeal on Thursday, December 13th, when it was decided by a majority of two judges out of three that a chemist fulfilling the duties that ordinarily fall upon him in a chemical works is not a "workman," and is therefore outside the scope of the Workmen's Compensation Act of 1897.

The facts of the case are as follows:—Some years ago Messrs. Levinstein, Ltd., aniline dye manufacturers, &c., of Manchester, engaged the services of a Mr. E. H. Bagnall, who was a Master of Science of Manchester University. The agreement was, perhaps, much more binding and full of petty detail than is customary; but shorn of legal technicalities and matters that have nothing to do with the present question, it appears to have retained Mr. Bagnall's whole time as a research chemist and as a supervisor of certain manufacturing processes outside the laboratory. The position, indeed, which he occupied, we believe, was strictly identical with that of the great majority of chemists employed in factories; it is well known in Germany under the name of "Arbeiter-Chemiker," and is often outwardly distinguished by the fact that a "gentleman" of high education is to be seen in working hours attired in soiled rags or slops and wooden boots, with hands stained bright yellow or grimed with dirt. Last January Mr. Bagnall scratched his leg in the factory, contracted blood-poisoning, and died. An arbitration was held afterwards at the Manchester County Court, when his Honour Judge Parry awarded Mr. Bagnall's widow £300 compensation on the ground that a man performing manual labour was, as a fact, a "workman," even if he were a Master of Science, a Doctor of Divinity, or the President of the Royal Academy.

An appeal was lodged, and came before the Master of the Rolls, Lord Justice Cozens-Hardy, and Lord Justice Farwell. In a lengthy judgment, the Master of the Rolls, following the House of Lords in another case, decided that the question what such an employé as Mr. Bagnall had been, was a mixed question of law and of fact, and that, therefore, the Superior Court was competent to interfere. He added that, no doubt, a workman was not less a workman because he had acquired academic distinction in science; but that if a man was employed as a Master of Science for the purpose of bringing his scientific knowledge and skill to bear on the business of his employers, he was not employed as a workman. If he was employed for the benefit of his attainments with a view to his discovering improvements in scientific processes, the mere fact that his work involved some manual labour did not make his employment that of a workman. In such a case a man was employed as a scientific expert, and not as a workman. Lord Justice Cozens-Hardy

delivered judgment to the same effect, and, therefore, the case was remitted to the County Court Judge for a new trial. Lord Justice Farwell disagreed, remarking that he would be sorry to say that education was a bar to the benefits of the Workmen's Compensation Act. He thought that whether a man was or was not what was called a gentleman, and whether he was or was not educated, he might be a workman; that there was nothing which the deceased did in his employment inconsistent with his being a workman.

Hence, as long as this judgment of the Court of Appeal remains, the man who rolls tubs across a factory yard has an assured future in case of accident, and his widow may reckon on being provided for. The man whose brains are the mainspring of the enterprise, who has devoted many years and much money to acquiring the skill and special knowledge necessary to manage the tub roller and his compeers (and to find them employment), is a kind of outlaw, much cheaper to kill or maim.

So far as we are able to discover, there was nothing peculiar in Mr. Bagnall's engagement germane to the present issue; and therefore it would appear that the law of non-compensation must apply to every scientific assistant engaged in technology, be he chemist, engineer or electrician. Some years ago when the cry was raised that England's great need was a larger or better supply of men highly trained in science, we ventured to point out that their paucity or inferior quality (if the latter defect be admitted) was largely due to the indifference of manufacturers, and to the low salaries offered. An additional reason now appears. The so-called workman who does the work which is lowest in quality, is a workman in very deed, encouraged and patted on the back by our legislative and administrative authorities; but the poor man of science is not of sufficient importance to the country to be worth mention in an Act of Parliament.

Boiler Limitations.

The general tendency in engineering is towards compactness. Lighter but stronger girder-work characterises civil engineering structures. The compact high-speed steam engine, or more compact turbine, would be unthinkable to any engineering Rip Van Winkle emerging from a sleep commenced in the days of Boulton and Watt. High speed and high pressure have wrought great changes in the steam engine so far as the amount of duty per cubic foot of space occupied goes. In the steam engine it seems as though the bed rock of compactness has been almost reached. But in the boiler house we find a demand for a large amount of floor space, and a certain amount of head room, which recent practice has done little to reduce.

The problems confronting the boiler designer are manifold. High pressures and demands for large quantities of steam mean, on the one hand, thicker plates or thicker tubes, and on the other, the most rapid transference possible of heat through the plates to the water. Now, whereas it is possible to get either 1 lb. of steam at 21 lb. absolute pressure per square inch into a vessel of 19·73 cb. ft. capacity, or to get 6 lb. of steam at 133 lb. absolute pressure per square inch into the same amount of space, water remains a practically incompressible fluid, with the result that all the developments of science will not get a quart of water into a pint pot. Therefore, an appreciable water space either within a shell, or in tubes, remains necessary for all save "flash" boilers. The rate of transference of heat through plates has been studied by many engineers. It depends somewhat upon the thickness of metal to be traversed, but mainly upon the difference of temperature, upon the circulation taking place within the boiler itself, and upon the molecular mobility of the water, which increases with an increase of temperature. It has been shown that while the mean evaporation per square foot of heating surface over an entire boiler may have a certain value, beloved in some engineers' specifications, the evaporation in certain parts is very much greater, and in other parts indubitably less. This will always remain the case while the products of combustion leave a boiler at a low temperature. A much greater all-round evaporation within a boiler can be secured by increasing this temperature, but at the expense of the economy of the boiler.

It is obvious that where flue-gas temperatures are high this waste of heat should be reduced, and every sane engineer seeks out a feed-water heater to reduce it. Therein the number of thermal units transferred per unit area per hour is, of course, much lower than in the boiler, and the total space occupied is greatly increased.

Heating with live steam as an auxiliary to the ordinary feed-water heater has been tried with very successful results, and hopeful auguries for the future, by Mr. G. Wilkinson and others. The root principle seems to be that if the already heated feed water—which is, say, 120° F. in temperature below that of the steam—is heated further by live steam, so that it enters the boiler at a temperature only 10° or 20° F. below that of the steam, the boiler then assumes the function of an apparatus in which steam is produced from water in its most mobile condition, and an all-round saving is secured.

This certainly saves space so far as flue gas-heated feed heaters are concerned; but it still leaves the boiler plant an unduly bulky machine for the engineer to handle. Many minds are being exercised in the endeavour to save space, material and capital outlay, without increasing thermal losses. Speaking of high boiler efficiencies, about 15 months ago we drew a parallel between the cost of the last knot in express steam-ship speeds and the last fraction of 1 per cent., when the thermal efficiency was already in the eighties. That desirable attainment—space-saving in the boiler house, or what amounts to the same thing—increased transfer of heat per unit area of heating surface over an entire system, has entered upon the category of similarly difficult feats.

Wireless Telegraphy.

While Lord Stanley has written to the *Times* to bless the Berlin Convention as entirely in accord with the views and intentions of the late Government, Sir Edward Sassoon has condemned it with at least equal emphasis, and on Tuesday the latter succeeded in inducing the Government to appoint a Select Commission to inquire into its provisions. The Convention will not come into force until July, 1908, and therefore there is plenty of time in which to weigh the matter in all its bearings before ratification. There appeared to be a strong feeling on both sides of the House as to the necessity of further inquiry, in order to ascertain whether our strategic and commercial interests were adversely affected, and the Postmaster-General placed no obstacle in the way. Mr. Buxton pointed out the obvious fact that the British Government could not well refuse the invitation to an International Conference, called together ostensibly for the public benefit; such an act would at once have placed us in a position of antagonism to the whole world on this question, and would have cut us off from all possibility of influencing the proceedings and safeguarding our interests, while it would have practically challenged our competitors to do their best, or their worst, to render our wireless service ineffective.

The immense advantage which we possess, and of which we cannot be deprived by any convention, in having in our possession or under our control important naval stations and an enormous length of coast line in all parts of the world, combined with our supremacy in maritime commerce, undoubtedly gives us the right to a controlling voice in the drafting of any such agreement; at the same time it constitutes an obstacle exceedingly difficult to overcome by any manœuvres on the part of our rivals, and in the present instance we believe that our interests have not been materially injured in any respect. Nevertheless, it is highly desirable that the matter should be fully investigated, and we trust that the Commission will do this effectually.

SOME PRACTICAL NOTES ON THE COMMERCIAL DEVELOPMENT OF ELECTRICITY SUPPLY UNDERTAKINGS.

By R. BORLASE MATTHEWS, Wh. Ex., A.M.I.C.E.

Shop Window Lighting.*

In conjunction with an aggressive electric sign campaign, arguments should be advanced, and suggestions made to the shop-keepers to the effect that in this advertising age, the day of the shuttered shop has passed. It is difficult, of course, to displace long established customs in favour of what apparently appears to be such a radically dangerous move as leaving the shop windows unprotected at night after the shop has been vacated. As a matter of experience, however, the danger of burglary is much lessened, especially when the practice is adopted of leaving a single light burning all night, so that the police and other passers-by can easily see inside the shop from the street, as in that case it makes the risk of detection to a burglarious person who has entered from the rear of the premises so much greater. The premium required, in any case, by insurance companies who make a speciality of insuring against burglary is not great, and is far outweighed by the value obtained from the advertisement. Many shops, though not shuttered, still draw down their blinds when closed, and thus lose valuable advertising opportunities, which fact must be brought home to them, and they should be the more easily convinced, since they already appreciate that it is not necessary to use shutters.

In the general scheme of the lighting of shops, it cannot be too distinctly explained to the owner of the shop, that that portion of the light used in the windows is really light-advertising, and that in the consideration of the amount of money that is to be expended on current consumed there, this fact must be fully taken into account.

There is a mistake in shop window lighting which is frequently made, probably due partly to the ignorance of the shopkeeper or the wiring contractor, or, perhaps, both, in that the lights employed often shine right into the eyes of the onlooker, which is not only annoying, but also prevents the goods displayed being seen to their best advantage. Shop window lighting may be divided into two main classes according to the purpose they are intended to mainly serve, first, that in which the object is to display the goods, and secondly, that in which the object is to draw the attention of those passing at a distance to the window. It will be noticed in well-lighted shops, that is well-lighted from the illuminating engineering point of view, even where a great display of light is made outside by the aid of luminous or flame arc lamps, that, in addition, the show window itself is taken care of by independent concealed lamps, generally placed at the borders or tops of the windows, full advantage being taken of reflecting mirror and patent systems, such as "Linolite." These facts are, of course, well known to electrical engineers, the important thing is to keep hammering them into the shopkeepers.

Electric shop-window lighting is fast getting to be an unassailable stronghold (almost regardless of the price charged for current) in the competition with gas interests, the strongest point of vantage being the possibility of concealed lighting.

A point that should be carefully attended to by the central station in advising the lay-out of an electric light installation for a shop that has previously been using gas, is to see and also to insist that for the first three months or so the shopkeeper only gets a light which is comparable with his former gas illumination; this will make him satisfied with his bills. Afterwards, when he sees how much better lighted other shops are and wishes to increase his own lighting, as he is sure to do, he will appreciate that his electric light bills are greater in amount than his former gas bills, not because electricity is an expensive luxury, as some uninformed people erroneously say and think, but because he is using so much more light. A great deal of trouble has been caused to central station managers by the general dissatisfaction as regards cost of current, aroused by the complaints of new consumers who have put in electric lights with a lavish hand, getting three or four times the light they previously obtained from gas, being aggrieved when they find the bills are greater. A little sound advice at the start would eliminate this source of complaint.

The smaller shops are very well worth looking after, and though the income from them individually may not be very great, they form a very good advertising medium for the central station, and are of importance from their very numbers. The small shop proprietor is, naturally, more appreciative—more talkatively appreciative than some of the larger business houses. Then again, it is but a step from electric light in the shop to electric light in the home of the proprietor. And so on, from his house to the homes of his neighbours and friends, the good work invariably goes on, forming a chain of new adherents, which is, or ought to be, welcome to the central station.

These small shopkeepers are not apt to rush down to the central station, begging for information on the question of electric light; more probably they have not even considered the question of proper illumination, having plenty of troubles of their own to occupy them. Therefore it is especially necessary for the central station to lay itself out for canvassing them.

The installation of electricity, where it has not been used before, serves as an example, an invitation for others to follow suit, for it is written in the books that a pleased customer does not keep still, but rather talks among his neighbours and fellow tradesmen.

When the small shops, as well as the large ones, begin to use electric light, people generally appreciate that electricity is not a thing set apart for the well-to-do only.

Almost every line of human endeavour is suggested by example. Every evolution grows into an accepted institution by somebody initiating it, and others following. No matter how many shops are using electric lighting, if that electric lighting does not demonstrate that it is superior to oil or gas, it cannot, and will not, stimulate other shops to install electricity.

Of course almost any form of electric equipment is better than oil lamps or gas, but is it not better to induce every shop in a town to discard its old-fashioned lights and come to electricity?

The better the example in the stores that are now electrically lighted, the more convincingly will electricity appeal to the shops that have not got it. Hence the argument that the central station should assist in the lay-out of the illumination scheme for these shops is a very strong one.

In connection with shop lighting, propositions should be arranged in conjunction with electric sign proposals, dealing with arc, Nernst, and other lamps. A policy similar to that adopted for electric signs should be carried out. The scheme should be modified in accordance with the hours of burning expected, the shop window lights coming under very much the same class as electric signs, whereas the interior lights are used for shorter hours. Some convenient easy-payment or hire-purchase system should be adopted, or, perhaps, better still, a minimum current consumption guaranteed on the basis of the so-called "free use" of the apparatus. It is very important to include the cost of maintenance, renewal and trimming in such propositions. In cases where the central station is operated by a municipal authority who have not full powers covering the so-called "free" propositions, arrangements should be made whereby all the lamps in the town should be trimmed by one contractor under a special agreement, made, say, on a yearly basis, so that the actual cost of trimming to the consumer be reduced as much as possible. That is to say, that the central station should act as an intermediary between the contractor and the consumer, ensuring a more satisfactory arrangement for both parties. This suggestion of arranging for the trimming to be done by one contractor, is made upon the assumption that bids for the work, say, for one year, be received from any contractors interested and the most favourable accepted. If all the lamp trimming required in a town be in the hands of one firm, they can do the work systematically at a lower price than could be done were each shop-keeper to make an individual arrangement.

Competition.

The position of the central station as regards competition is, of course, a very important factor in laying out the policy

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* Previous articles of this series appeared on pages 650-1, 656-7, 728-9, 808-9, 849-850, 888-9, 929-30, and 971-3 of the current volume.

of the new business department. Where there is no competition other than oil, this very lack of competition is, to a certain extent, a difficulty, as the advantages of a better illuminant are not fully realised. The remedy is obvious—active education.

In the case of gas competition, an energetic campaign on either side will, strange to say, cause an increase in the business of both parties, owing to the awakened interest of the populace, who, having been aroused, investigate the merits of electricity and gas for themselves. Experience has proved that there is ample room for both. Friendly relations should be maintained with the gas company, and such courtesies as are of mutual benefit should be extended; for example, if either cuts off a customer on account of non-payment of bills the other party should be at once advised, so that in due course they may not find themselves in the same plight.

Where the electric and gas interests are combined, it is well to let the staff of each department compete for new business in friendly rivalry; at the same time, an endeavour should be made to avoid unnecessary transfer of business branch to the other, or duplicate the installation for small consumers.

The competition most to be feared is that of another electric company. It is a generally accepted fact that no city having a population of under 300,000 can support two electric supply companies. Eventually they must get together, and the general public will then have to pay dearly for the benefits derived during the period of competition. The duplication of the plant, the double distributing system, the cutting of prices to the limit at which there are no profits, mean the investment of much capital, upon which interest must be recovered at some time or else the shareholder will suffer.

Owing to the small and limited field of operation, this form of competition is much worse than can arise in any other kind of business, and it is a bitter struggle until the consolidation is brought about.

Fortunately, under the present administration in this country, this form of competition is not often permitted.

The public has respect for the large advertiser, getting the impression, somehow, that his business corresponds in quantity to his advertising activity. The competition is going to arouse great interest in matters electrical, so it will pay to get busy.

If the electricity supply stations are to show satisfactory results, they must be allowed to compete under the same conditions as their gas competitors, that is, in the way of getting their product into the consumer's hands in a useable shape, by offering the inducements of "free" signs, "free" wiring, "free" heating apparatus, &c., or making other arrangements for renting or sale on easy terms.

PROCEEDINGS OF INSTITUTIONS.

Regenerative Control of Electric Tramcars and Locomotives.

(*Paper read before the* Institution of Electrical Engineers *at Leeds, by* Alfred Raworth.)

Discussion (*concluded from page* 934).

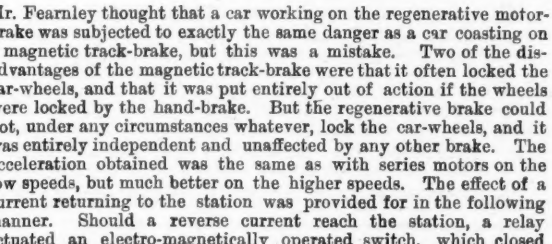
Mr. J. S. Raworth said there was one element in the theory which was apt to be lost sight of, namely, that for any given field strength there existed a definite speed of armature varying only to a very slight degree as the machine changed from motor to generator; and, secondly, that with any given armature speed the field strength was the same whether it were produced by shunt winding or by series winding. As regards heating, it was obvious that the regenerative motor must run at a higher temperature than the same size of series motor. The practical question to be decided was whether the higher temperature exceeded the limit at which deterioration of the insulating material commenced. Up to 212° F. there was no deterioration. One of the great advantages of the system described in the paper was that it could be applied to existing motors, but they never undertook to convert a motor which was already overworked, and if they supplied new motors they selected some with a good margin of power. The tests of temperature quoted in the paper and by Mr. Goldston, of Spen Valley, showed that the heating was not excessive. Mr. Parshall informed him that 160° F. was well inside the safe limit, as all the motors on the London electric railways were running at that temperature and giving no trouble. Provided, therefore, that they did not go beyond the limit of speed they were no more likely to burn out at 160° than at 120° F. Sparking at the commutator had entirely ceased since they had perfected the paralleling controller. The points raised in Mr. Baxter's communication are nearly the same as those referred to by other speakers. The normal specified rise of temperature on one hour's test at rated load is 75° C., or 135° F. The quoted tests show that this limit was never reached. The reason why the car stopped more frequently in descending the Crystal Palace Hill than in ascending, was because the Board of Trade had fixed a number of compulsory stops on the down grade. If the cars proposed to be converted were already fitted with magnetic track-brakes, they would act a good deal more effectively with this controller and these motors than with the ordinary series motor, because they were not dependent on building up after the handle was moved on to the braking notches.

Mr. Alfred Raworth, in reply, said Mr. Goldston had taken some temperature readings on both series and regenerative motors on the Yorkshire (Woollen District) Tramways; the weight of the cars in all cases was 9 tons, and they were in service for 16 hours. The type of motor was 1,202 B. Brush, the regenerative motors being series motors rewound:—

	Series motors.	Regenerative motors.
Armature winding	120°, 110°	132°, 148°, 135°
Commutator	132°	170°
Field windings...	105°, 100°	120°, 102°, 130°
Atmosphere	55°, 60°	55°, 60°

Readings in degrees Fahrenheit.

Mr. Fearnley thought that a car working on the regenerative motor-brake was subjected to exactly the same danger as a car coasting on a magnetic track-brake, but this was a mistake. Two of the disadvantages of the magnetic track-brake were that it often locked the car-wheels, and that it was put entirely out of action if the wheels were locked by the hand-brake. But the regenerative brake could not, under any circumstances whatever, lock the car-wheels, and it was entirely independent and unaffected by any other brake. The acceleration obtained was the same as with series motors on the low speeds, but much better on the higher speeds. The effect of a current returning to the station was provided for in the following manner. Should a reverse current reach the station, a relay actuated an electro-magnetically operated switch, which closed a circuit between the bus-bars through a resistance, as shown below.



Immediately the current resumed the normal direction, the switch reset itself. This apparatus effectually prevented any damage being done to power station gear. The controller was provided with the usual motor cut-outs. The automatic switch on the car only operated when the voltage across the motors rose above 600, and this only happened when an open circuit occurred. Should a trolley leave the wire the switch operated immediately, and the motorman could reduce the speed of the car to two miles an hour by the ordinary movement of the controller handle. Mr. Jenkin's conclusion that a dirty commutator or controller might influence the braking effect of regeneration was wrong, the circuits used for regenerating being exactly the same as those for propelling, and the voltage slightly greater; it followed, therefore, that if the motors would not regenerate, neither would they pull, consequently the car could not be taken out. The extra cost of a regenerative equipment over a standard type was approximately £40 per car. They had not so far designed a motor for regenerative control. All the motors which were running regeneratively were "series motors," with the series coils replaced by shunt coils. He would like to pay a tribute of appreciation and thanks to Mr. Paris and Mr. Goldston for the very valuable assistance which they rendered during the experiments with, and the development of, the series-parallel type of controller.

Rotary Converters v. Motor-Generators.

By Miles Walker, B.Sc.

(*Abstract of Paper read before the* Institution of Electrical Engineers *at Manchester, December 4th,* 1906.)

Owing to the extension of large power systems, it is probable that, in the future, the bulk of the D.C. supply will be converted from A.C.; the author proposes to show the great advantages of rotary converters over all other commercial apparatus for this purpose.

For traction systems, where the frequency is low, the rotary converter is indisputably the best apparatus for converting; in London alone there are rotaries of 147,000 KW. installed for traction work, and giving the most efficient service.

For electrolytic work rotary converters are well adapted, and at

Newcastle three 1,000-KW. rotaries have been installed to supply power to the Castner-Kellner Co.

For lighting and traction with A.C. at 40 or 50 cycles, contrary to general opinion, the rotary is quite satisfactory, and 50-cycle rotaries of 150 to 1,500 KW. are running in this country.

The following table shows the main features of the various converting apparatus available.

——	Starting.	Synchronised.	Parallel operation. A.C. side.	Parallel operation. D.C. side.	D.C. voltage. Variation with A.C.	D.C. voltage. Variation with frequency.	D.C. voltage. Hand adjustment.	Compounding.	Commutation.	Overload capacity.	Risk of breakdown on H.T. side.	Power factor.	Efficiency with transformers 1,000 KW.	Attention.	Floor space.
Rotary converter ...	Starting motor Start D.C. side Self-starting	Yes Automatic	Good	Good	Yes Automatic regulator	No	Yes	Yes	Excellent	Very great	Small	Unity	94½ %	1	1
Motor-converter (Peebles La Cour)	Self	Yes	Good	Good	Yes	No	Yes	Yes	Good	Fair	Greater	Variable	92½ %	—	1¾
Synchronous motor-generator	Starting motor Start D.C. side Self-starting	Yes	Fair	Good	No	Yes Bad	Yes	Yes	Fair	Fair	Greater	Unity	90 %	2	2¼
Asynchronous motor-generator	Self	No	—	Good	No	Yes Bad	Yes	Yes	Fair	Fair	Greater	Variable	89 %	1	2¼
Permutator... ...	Starting motor	Yes	—	—	Yes	No	—	—	?	—	Small	—	95 %	—	½
Electrolytic rectifier	—	No	—	—	Yes	No	—	—	—	—	Small	—	—	—	—
Vacuum rectifier ...	—	No	—	—	Yes	No	—	—	—	—	—	—	High	—	—

Starting.—The usual practice with large rotary converters is to employ starting motors; but it is possible to start up either on the D.C. side or on the A.C. side. For low-frequency rotaries, starting up on the A.C. side without starting motors and without synchronisers can be recommended. Where it is necessary to cut down the starting current to the lowest possible minimum, ball bearings may be used with safety up to the 500 KW. size. For larger sizes special provision can be made in the design of the rotary to limit the starting current to a very small amount. A self-starting rotary may have attached to it a small exciter in order that its polarity may with certainty be brought up the right way in the first instance. The process is in all respects as simple as the starting-up of an induction motor-generator set. The position of the motor-converter in the matter of synchronising is the same as that of the the rotary. When suitable switching arrangements are made, it is just as safe and as easy to start up a rotary on the D.C. side as it is to start up a motor-generator in this way. The objection which has been raised to starting up a rotary on the D.C. side is that in adjusting the speed for the purpose of synchronising with the A.C. side, the field current has to be altered, and it does not necessarily follow that at the time of synchronism the A.C. voltage of the rotary is equal to the A.C. voltage on the bus-bars. If the A.C. switches are closed under these conditions, a very large current might flow from A.C. to D.C. or from D.C. to A.C. The following arrangements, however, have been made to meet this difficulty, and are successfully employed on large rotaries in New York. The A.C. switches are electrically controlled. By a small addition to the D.C. circuit breakers, the current which operates the A.C. oil switches is made to pass through a tripping coil, which trips the D.C. circuit-breaker a fraction of a second before the A.C. circuit breaker is closed. With this arrangement a rotary converter can be run up as a D.C. motor, its speed adjusted until the rotary is in phase with the high tension bus-bars, the electric control switch for the oil switch is then operated, and the rotary taken off the D.C. bus-bars a fraction of a second before it is placed on the A.C. bus-bars.

Parallel Running.—There is a prevalent opinion that a 50-cycle rotary converter hunts; this is true of a badly designed rotary converter, but is not true of a properly designed machine when working under reasonable conditions. The parallel running on the A.C. side of a rotary converter is really considerably better than the parallel running of a synchronous motor-generator set, because the rotating part being lighter, the speed can be more easily changed to meet the sudden changes of frequency. The disadvantage of the synchronous motor-generator in this respect is to a certain extent shared by the Peebles-La Cour motor converter. It is not true that the motor converter has a greater synchronising power than the rotary. The synchronising current taken by a rotary is only limited by the resistance of the line and the small resistance and self-induction of its armature, whereas the synchronising current of a motor converter is limited by the self-induction both of the stator and rotor of the induction motor end. With regard to the parallel running on the D.C. side, all types stand on the same footing.

Variation of Voltage.—As to the variation of the D.C. voltage with the A.C. voltage, the table shows exactly what the position is. The D.C. voltage and the A.C. voltage of both the rotary converter and the motor-converter vary together. The simple motor-generator has an advantage in this respect in that the D.C. generator is entirely independent, and so long as it is running at constant speed and load gives a constant voltage. In cases where the A.C. voltage is unsteady and it is required to preserve a constant D.C. voltage, the motor-generator will be the simplest apparatus to employ, but the superior efficiency of the rotary converter will sometimes make it worth while to introduce automatic voltage regulators, so that a steady D.C. voltage can be maintained, notwithstanding variations in the A.C. supply. Automatic regulators have been designed which will hold the D.C. voltage constant within ½ per cent., notwithstanding the variation of the A.C. voltage through a range of 10 per cent. The D.C. voltage of a rotary is not dependent upon the frequency, whereas with the motor-generator a change in the frequency of 1 per cent. will often make a change in the D.C. voltage of 2 per cent.

Hand Regulation of Voltage.—It is possible to carry out hand adjustment of voltage through wide ranges on all four classes of apparatus. In the case of a rotary converter, there are four methods by which the adjustment of voltage can be obtained.

The simplest method is to build the transformers feeding the rotary with a high inductive drop. The rotary then behaves very much as a shunt generator. By increasing the excitation we increase the voltage; by decreasing the excitation, we decrease the voltage. The only drawback to this method is that the power factor varies as the voltage is varied.

The second method for obtaining hand adjustment of the voltage is to put an alternating-current booster on to the shaft of the rotary, and change the A.C. voltage supply of the rotary by varying the field of this booster. In the rotary converters recently supplied by the British Westinghouse Co. to Bristol, Bradford and Moscow, this method has proved in every way satisfactory. For instance, at Bristol the rotaries are designed either for lighting from 460 volts to 500 volts, or for traction with automatic compounding from 500 to 570 volts.

In addition, this booster enables us to preserve complete control over the power factor, notwithstanding any change in the voltage. In all cases where a very wide range of voltage, say, up to 25 per cent., is required, the booster method is to be preferred to the self-induction method.

The third method is by connecting an induction regulator between the transformers and the rotary. The 1,500-KW., 50-cycle rotary converters operating at Brighton obtain their voltage regulation by means of induction regulators. One of the objections to the use of these regulators is that they require cooling by an air blast; this, however, is not a serious objection where air-blast transformers are used. In cases where an air blast is available, the induction regulator is to be preferred to the A.C. booster, if the number of poles on the rotary is very great.

The fourth method of adjusting the D.C. voltage is to bring taps from the transformers either on the H.T. side or on the L.T. side, and change the working tappings by means of a dial. There will, of course, always be an objection to any system in which tappings from the transformer are brought to a dial, on account of the possibility of accidental short circuits.

Compounding.—All four classes of converting apparatus are the same in the matter of automatic compounding. It is just as easy to obtain a compounding effect of 10 per cent. between no load and full load on a rotary converter as it is on a motor-generator. This compounding can either be carried out by putting a series coil on the field of the rotary and self-induction in the transformers feeding it, or by adding a series coil to the A.C. booster fixed on the shaft.

Where it is intended to run rotary converters in parallel with shunt generators, the transformers should be designed with considerable self-induction, and a reversed series winding should be put on the rotary converter. This gives the rotary all the characteristics of a shunt machine.

Commutation.—It is common knowledge that the problem of commutation on a rotary converter is very much easier than on direct current machines, as there is very little field distortion by the armature current, so that excellent commutation can be obtained through very wide ranges of load. Even up to three and four times full load, current can be collected from a rotary converter without excessive sparking or flashing over, and up to 100 per cent. overload can be commutated sparklessly.

In a recent test of a 50-cycle 250-KW. rotary converter, the machine, when running on three-quarter load, was suddenly overloaded 250 per cent. without causing serious sparking.

Risk of Breakdown.—For smallness of risk of breakdown, the rotary converter and its transformers are superior to any other converting machinery, because there is no high voltage on the running machine, and there is only one running machine to break down, instead of two. A well-insulated transformer is very much less liable to break down than any kind of high-voltage armature. Even if one of the transformers does break down, the load can be carried on the other two.

Power Factor.—The power factor of a load of rotary converters can be adjusted to any desired figure by varying the excitation.

The rotary converter and motor-converter are much the same

in the matter of adjustment of power factor, the main difficulty being that the induction part of the motor-converter always has a high self-induction, and therefore, with changing load and changing frequency, the power factor will always be beyond the control of the operator, whereas, with a rotary converter, where it is important to preserve unity power factor at all loads, the self-induction in the transformers can be made extremely small, and an A.C. booster can be added in cases where variation of voltage is required, so that the power factor is always completely under control.

Efficiency.—Here the rotary converter has a substantial advantage over any other type of converting apparatus. It is not true that the motor-converter has all the advantages of a motor-generator, and as high an efficiency as the rotary. In comparing the efficiencies of different machines, it is very important to consider the basis of their ratings. When a sub-station is supplying a town load, it is always necessary to have enough machines running to avoid catastrophe in the case of sudden unexpected demands. The efficiency of the sub-station will greatly depend upon how many machines are running, and how near to full load they are working. If the station is provided with rotary converters, it is in most cases perfectly safe to have all the rotary converters fully loaded and allow them to be overloaded before a new machine is thrown in. When dealing with motor-converters or motor-generators, which are not able to take such excessive overloads without danger, the station engineer is not justified in normally running his machines up to such a high point. He must, except for the very steadiest loads, always have some capacity in hand to meet sudden demands and give him time to throw in other machines.

Attention.—In the amount of attention required to keep a machine clean and in good running condition, the rotary converter is just twice as good as its competitors. There is only one machine to keep clean instead of two, and, moreover, the easy commutation enables the carbon brushes to run for years with only the slightest wear.

Floor Space.—In the matter of floor space, the rotary is again at the head, provided the transformers can be placed in a lower or upper storey, as is often the case.

Cost.—In the same factory, with the same class of materials, theoretical considerations show that the rotary converter and transformers should be cheapest to build. The actual market price is governed by a large number of considerations which are out of the sphere of this paper.

Discussion.

The Chairman (Mr. T. L. Miller) said that the transformers could not always be placed on the switchboard gallery. In the past there had been considerable difficulty in running rotaries at 50 cycles; he had lately seen a paper, read before the American I.E.E., and in the discussion upon it very few members spoke in favour of rotaries for 50 cycles. Efficiency was a trifling matter compared to a shut down. The author drew attention to the fact that the D.C. voltage varied with the A.C., and pointed out that it could be got over by installing a D.C. voltage regulator; all these different appliances cost money. Engineers were concerned with the selling rather than the shop cost of rotary converters.

Mr. S. L. Pearce did not think that anyone present would deny that the 25-cycle rotary was the correct plant for traction. He visited Newcastle some weeks ago and was surprised to find motor-converters alongside the rotaries for the Castner-Kellner Co.; it would be interesting to know why this was. He agreed with the first eight columns in the table. It was possible to start with small motors, or on the D.C. side; starting on the A.C. side took a deal of time. With a motor-converter it was possible to start on A.C. and D.C., the former preferably. There was no piece of sub-station apparatus over which he had charge, so easy to control as a motor-converter. On the question of parallel running, he could not agree with the author. With regard to regulation, a variation of 8 per cent. to 9 per cent. in the power factor with 5 per cent. to 10 per cent. voltage variation, appeared to be rather wide for ordinary conditions. Tests he made at Manchester on motor-generators showed that with 420 volts the power factor was 1, with 450 volts 98 per cent., a variation of 7½ per cent. The machines were running all day with a voltage of about 420, and the bulk of the time the power factor was 95 per cent. Referring to the tests on the 250-KW. 50-cycle rotary converters mentioned, he thought the results were excellent, but the motor-converter, from records in his possession, was very little inferior. Tests had been carried out in which he had run a 450-KW. motor-converter at 800 KW. for one hour, and a 250-KW. at 400 KW. for the same period, with perfectly satisfactory results. The efficiency of the rotary converter was superior to all classes, but on all-day running it was not more than 1½ per cent. He had recently invited tenders for rotary and motor-converters, and found that he could get in the space available on the same level, motor-converters equal to 13,500 KW., but only 9,000-KW. of rotary converters.

Mr. J. H. Bowden said about three years ago he advertised for tenders for motor-generators, and at the same time considered alternative tenders for rotary converters. He chose the latter, on the score of simplicity, low cost, greater efficiency and more stability. The addition of the exciter was a further complication which was not possible in the motor-converter. It was very much easier and quicker to synchronise with the motor-converter than with the rotary converter. The addition of the voltage regulator and A.C. booster were further complications. At Poplar he had a 500-KW. motor-converter running week in and week out, and only stopped three or four hours per week for cleaning. He had heard nothing that would induce him to recommend his committee to place an order for rotary converters in place of the type of plant which was already installed.

Mr. Cramp said the author had tried to compare the rotary converter with the motor-generator; to obtain the same results he had to employ all sorts of accessories. Nothing had been said in the paper or discussion on the question of extra switchgear required for rotary converters, which was another complication. The question of cost should be compared by taking rotary converters and accessories and motor-generators and accessories. As regarded efficiency, the rotary converter was admittedly high, but what did the extra 1 per cent. mean, and what was it worth in capital outlay? He thought the rotary converter would do for railway and tramway work, but not for combined lighting and traction.

Mr. J. S. Peck said he never appreciated the prejudice against rotary converters in England more than he did that night. The rotary converters at Newcastle had been operating successfully ever since they were installed, which could not be said of the motor-generators. In general it was not well to run rotaries in parallel off the same transformer unless a separate secondary was provided for each machine. Faults in rotary converters were heralded around, whilst nothing was heard of the faults of motor-generators.

Mr. Southgate did not think that the rotary converter would cost any more to build than the motor-generator. He did not see why a lot of additional switchgear should be placed between the secondary and the rotary. In America the G.E. Co. had made 60-period rotary converters which were doing well.

Mr. T. H. Schoepf referred to a sub-station he had charge of in 1899. The plant consisted of six 300-KW. 60-period rotaries which were started by starting motors. On one occasion he had the whole plant running in ten minutes from the time of arrival, and considered that the motor-generator could not beat that. There was only one failure in two years, which was caused by an inexperienced assistant, and not by the machine. One company had run a rotary converter without stopping for three months, and then only stopped it for new carbons. The difference in efficiency of 1 per cent. on, say, a 1,000-KW. machine, of which the average load would be 600 KW., at ½d. per unit, would be about £110 per annum saving in favour of the rotary converter. It was, therefore, worth while to spend an extra £2,000 on rotaries.

Mr. F. H. Whysall said he found the average time taken to start the motor-generators was 1 min. 20 secs., which was better than the time stated by Mr. Schoepf.

Mr. La Cour said that as the 50-cycle motor-converter generally consisted of an induction motor coupled in cascade with a 25-cycle 12-phase rotary converter, it was evident that it closely resembled an ordinary rotary converter worked in series with a stationary transformer. From this they would readily understand the advantages which a 50-cycle motor-converter possessed over a 25-cycle rotary converter. Mr. Miles Walker claimed that the small mass and low reactance of the rotary converter were advantageous; he thought the contrary. It had long been known that the 50-cycle synchronous motor-generator which had large revolving masses and a fair amount of reactance was a much better machine than the rotary for stability; from this it was obvious that the 50-cycle motor-converter must have an advantage over the 25-cycle rotary. The motor-converter stood at good advantage in this respect, since it had a fair amount of fly-wheel effect and reactance; the first tended to steady the system, and the second prevented the motor-converter taking up a large synchronising current, which consisted of higher harmonies when running light. The revolving field of the induction motor also had the same effect, so that the motor-converter did not take any synchronising current at all. From experience extending over many years it had been proved that machines with large synchronising forces and small fly-wheel effect were more liable to cause hunting than machines with a fair amount of reactance and fly-wheel effect. The reactance voltage of a transformer designed on normal lines was about 3 to 4 per cent. of the working pressure, while the reactance of an ordinary induction motor varied between 15 per cent. and 20 per cent. An increase in reactance meant more copper and less iron, and as iron was cheaper than copper an increase in the reactance over a certain limit (which was fairly low in the case of a transformer) would increase the cost of the apparatus. The commutation of a 50-cycle motor-converter was theoretically considered inferior to the 25-cycle rotary, but by means of commutating poles it was possible to obtain sparkless running with well over 100 per cent. overload. As the overload capacity of rotaries was generally limited by hunting and not by sparking, it was easily seen that the 50-cycle motor-converter from the operation point of view was superior to the 25-cycle and far superior to the 50-cycle rotary. The 50 and 60-cycle rotaries had many poles, high peripheral speeds and small distances between the brush spindles, so that these machines were more liable to hunt and flash over than the motor-converters and 25-cycle rotaries. The machines recently supplied to the Great Western Railway were of the latest design, provided with commutating poles, and could withstand 100 per cent. overload, without signs of sparking. On one occasion an iron bar was accidentally dropped across the connections of one of the machines leading to the bus-bars, causing a dead short; the machine vibrated violently, but did not flash over. In conclusion, he felt convinced that the converting plant, as manufactured by Messrs. Bruce Peebles, had distinct advantages over the other forms, especially on the higher frequency circuits.

Mr. Miles Walker, in replying to the discussion, referred to the additional accessories required for a rotary converter, and said he only recommended a cheap transformer, and did not advise installing a booster unless the power-factor was required to be under complete control; if it was, then the booster would add about 10 per cent. The synchronising power of a motor-generator was not so good as a rotary. He considered the rotary converter worked very well, and for all practical purposes gave what was wanted. It did not take up much room, would do all the motor-converter would do, and gave 1½ per cent. more efficiency.

Institution of Electrical Engineers.

Manchester Students' Section.

On November 16th, Dr. E. W. Marchant delivered an address on the "Education of an Engineer." The chief aim of an engineering education, he said, was education in the first place, not engineering. If an education designed primarily for engineers did not train a man to think for himself, it was of very little use. The acquisition of facts, though, of course, a very important branch of education, was not the main object, and it was a truism that the acquisition of a great amount of book knowledge often led to the stunting of the mental faculty in the individual. The committee which had recently issued its report recommended that the first year after a boy left school should be spent in a workshop; the engineer should learn as early in his education as possible how things were done, and the way in which the doing was carried out in actual practice. The things he himself remembered were the things he had done, and not the things he had read out of books.

For an engineer then, the fundamental basis was an experimental one; he ought to be an experimenter throughout the whole of his career, and his training could hardly err on the side of having too much experimental instruction in it.

The second point seemed to be that he must learn to compute, but computation was not so important as experiment. He knew an engineer who invariably designed certain parts of his engines by eye, on the basis of his past experience, without ever putting pencil to paper to make a calculation, and there was in some engineers an engineering instinct which led them to proper design; the method was one that he did not recommend indiscriminately, but it was as well to bear the point in mind, as it showed how far experiment, on which computation was based, might be relied on to give the best results. A knowledge of mathematics was essential to an engineer, but it was not at all a difficult thing to have too much of mathematics.

It was becoming more and more generally recognised that the wider the basis on which an engineering education was built up, the better for the engineer. It was not enough for an electrical engineer to know the electrical properties of materials, the working of electrical machinery, and so forth; he must, if he was to take a proper point of view, know, for example, something about the prime movers that were employed to drive the electrical machines. It was difficult to over-estimate, therefore, the advantages of a systematic course of instruction. It was, of course, impossible that every student should study all the various branches of engineering; but he should study with considerable attention some of the branches outside the particular line he intended to follow, and which preferably had some connection with his own. It was an absolute necessity that the commercial aspect of the subject should receive consideration; the business side of the question was really the governing principle in design in many cases, not that which was mechanically ideal, and to neglect this question was fatal to success.

There was a great deal of truth in the statement that the education of a man really began when he had completed his college course. Such an engineering education ought to produce a man who was able to think straight, and to know his tools, not with a mere book knowledge, but from practical experience. But there was something else, namely, a very real idea of the enormous value of co-operation and discussion. In any properly constituted educational centre, a student learnt as much from his fellow students as from his teachers, and the same principle held in after life; without co-operation progress was far less rapid than with it. It was because of the known importance of this, that institutions like the Institution of Electrical Engineers existed. The freedom of discussion, the multiplicity of interests represented, the opportunity of gaining knowledge first-hand from the practical experience of others, were of incalculable advantage.

There was a distinction between engineering and money-making, and the man whose speciality was the making of money was bound to do it better than a man, like the engineer, to whom the making of money was technically a side issue. The engineer who entered his profession with the idea that he intended to make money would be a failure as an engineer, though he might, and should, if he had ability, prove a very successful money-maker.

Engineering was a world-wide profession and one of the objects of an engineering training should be to promote a catholicity of opinion, an absence of prejudice and insularity, and a capacity of judging the excellence of any work upon its merits.

With an open mind, however, the result of all this observation would be a strengthening of the pride they all felt in the great works that had been done by British engineers and an increase in the patriotism they all should feel towards the land in which they lived.

Newcastle Section.

On the 19th ult., the chairman, Mr. H. L. Riseley, read his inaugural address on questions of capital expenditure on power supply, of which the following is an abstract:—

The primary duty of the engineer is to ensure continuity of supply. The question then arises to what extent capital expenditure is justified in order to secure such a result. A happy mean has to be struck in installing plant which will operate continuously and efficiently with the smallest possible amount of cleaning and repairs.

Starting with the purchase of land for the erection of a power house, the sites will have to be in a suitable position in relation to the bulk of its business; to be readily accessible for coal supplies, with accommodation for storing four or five weeks' supply; to have an ample supply of good circulating water at a low lift.

If the maximum load only lasts a few hours per year, it is not policy to spend a large amount of capital on highly efficient plant when apparatus of more modest attainments will arrive at the end sought for, at less expense. This is purely a question of load factor, which in a lighting station must be very low, as quite half the plant in the station will only be required for about 300 hours per annum; consequently it is most important to keep down the capital expenditure on this plant. Take the cost of a modern power house equipment at £22 per kw., and interest and depreciation at 15 per cent.; then the standing charges per kw.-hour as above work out at 2s. 6d., and taking the operating costs at ·5d. we get the standing charges about five times the operating costs. It is, therefore, more important to keep down capital expenditure on that part of the plant which is only going to be used on peak loads than it is to make the plant highly efficient.

Since the days of reciprocating engines, and with the introduction of steam turbines, the capital charge has been reduced in the ratio of about £17 to £5 5s., owing to cheaper apparatus and smaller foundations required. This includes generating plant complete with condensers and engine house equipment. At the present time a great reduction can be effected by purchasing plant with a large overload capacity, contractors being prepared to guarantee plant having an overload capacity for two hours of 50 per cent. This, of course, on the understanding that the apparatus will operate efficiently at normal loads, but not necessarily with equal efficiency at overloads, but, as pointed out previously, this latter point is of minor importance in relation to the standing charges at peak loads.

As regards condensing plant, there is not much opportunity of showing any important reduction of expenditure upon this, as the apparatus has to work at the same rate, whether the generating plant is overloaded or not, but assuming a case where the whole equipment (generator and condensing plant) will only be used on peak loads in emergency, a considerable saving can be shown. A first-class condensing plant with air pumps, &c., will cost £1 per kilowatt, and would maintain a uniformly high vacuum, whereas an ejector condenser, or one of the barometric type, could probably be purchased for 5s. per kilowatt.

The majority of the auxiliaries should be steam driven, as they are cheaper in the first place, and the exhaust steam is usually used to heat the feed water. In some cases where the supply of exhaust steam from the auxiliaries is small, special steps have to be taken to heat the feed water. In at least one station the steam is being taken from the third stage of a Curtis turbine, after it has performed some work for this purpose.

Only sufficient reserve plant must be kept to preserve the supply from unnecessary interruption and to prevent the prestige of the power company from being injured. The standing charges on one large complete unit lying idle are enough to cripple the total costs of any moderate-sized station, and seeing that the machines of to-day are capable of doing large overloads, it seems that the correct thing is to regard the overload capacity of the various units as the reserve plant to the generating station.

The weakest point in any h.t. generating station is between the generators and feeders, this being the only place in a power station where it is absolutely necessary to duplicate the apparatus, especially the bus-bars, not only for the safety of supply but also to ensure flexibility of operation. The capital expenditure on switchgear alone appears to have increased by 50 per cent. during the last six years. This is due to the numerous safety devices installed and to the larger space now occupied by switchboards.

Engineers should aim at simplification and reliability, and due consideration should be paid to the installation of plant which will run continuously with a minimum of attendance and repair.

Birmingham Section.

The opening meeting of this Local Section was held at the University, on Wednesday, November 21st. The chairman, Mr. R. A. Chattock, chief electrical engineer to the Birmingham Corporation, who was to have delivered his address, was unfortunately unwell and not able to be present.

The chair was taken by the retiring chairman, Mr. Vaudrey, who referred to the success which attended the visit of the foreign electrical engineers to the Midlands, and said that they could claim a record if they compared their work with other local sections, in that all the papers that had been read before their Section had been printed in the *Journal* of the Institution.

Dr. Sumpner proposed a vote of thanks to the retiring chairman; to Prof. Threlfall, who gave them such a able address at the commencement of the session, but who was unfortunately compelled by business and private reasons to retire, and also to Mr. Vaudrey, for taking Prof. Threlfall's place and acting as chairman during the remainder of the session.

Mr. Henry Lea seconded this vote of thanks, which was suitably replied to by Prof. Threlfall and Mr. Vaudrey.

Mr. Chattock's address was then read to the meeting by the secretary; we reported it in abstract in our issue of the 23rd ult.

The Chairman, in a few words at the close of the meeting, gave an interesting account of the growth of the electric supply undertaking in Birmingham, and afterwards proposed a vote of thanks to Mr. Chattock for his address, which was seconded by Mr. Bate, and carried.

The Faraday Society.

Accumulators in Theory and Practice.

An interesting and instructive contrast was provided by two of the papers, one theoretical, so-called, and the other practical, so-called, read before the Faraday Society on December 11th. On the one hand, we had Dr Alexander Cumming, in a carefully worked out

investigation of the rigid scientific type, elucidating one or two obscure points connected with the "Electro-Chemistry of Lead," work which, although having little apparent bearing on the accumulator, is yet of the type which is bound in time to lay the foundation for sound theory, and, in the long run, to lead to improved practice among thoughtful engineers who base their work on an intelligent appreciation of the scientific principles really involved. On the other hand, there was a paper of the "practical" type, professing to deal with things "as they are," and as a result containing a heterogeneous mixture of observations and experiments, many of them, doubtless, of real interest and value, thrown together with little regard for order or sequence, and on the top of these what purports to be a comprehensive theory, built on so uncertain and inexact a basis of experiment, that true in part as the theory doubtless is, the lessons to be derived are as likely as not to be completely disregarded, on account of the want of confidence inspired by the author's loose method of expression and unscientific method of procedure. Of all this we hope the moral is obvious.

Dr. Cumming's paper was chiefly concerned with the measurement of the tendency of the tetravalent lead ion to pass to the bivalent ion (a tendency which may be looked upon as providing the E.M.F. of an accumulator), and of the bivalent ion to pass further into ordinary metallic lead. The method employed was to dissolve PbO_2 in nitric acid—usually stated to be an impossibility—to get plumbic lead, and to add ordinary lead nitrate for the plumbous lead solution. The potentials were measured with a lead peroxide electrode against a normal calomel electrode as standard, a saturated solution of ammonium nitrate connecting the two, because, as the author showed in another paper read the same evening entitled "Studies in Strong Electrolytes," such a connecting solution eliminates the contact potential between the solutions connected. The mean value for the tendency for the tetravalent $Pb^{\cdot\cdot\cdot\cdot}$ to become divalent $Pb^{\cdot\cdot}$ was finally calculated to be 1·82 volt, so that lead in its tetravalent form is a very highly electro-positive element. In the case of the sulphate solution, the value of the same tendency is found by calculation to be 1·72 volt, but it would be well for measurements in this important solution to be made independently, and thus act as a check on the theory. The direct measurements, incidentally required in the calculations of potentials, of the solubility of PbU_2 in sulphuric acid, similar to those given by Dr. Cumming for the nitric solution, would alone justify this extension of the investigation. Dolezalek, in his classic book on the "Theory of Lead Accumulators," bases his work on the supposition put forward by Liebenow, namely, that the primary anode action in the accumulator is the deposition of PbO_2 ions. Many objections to this hypothesis have been raised, and if Dolezalek's calculations could be revised in the light of Dr. Cumming's theory of the transformation of tetravalent to divalent lead ions, the foundations of a sounder accumulator theory in the light of the ionic hypothesis would be laid.

Mr. R. W. Vicarey's paper on "Storage Batteries and their Electrolytes," which was subjected to some severe criticism at the hands of Mr. H. L. Joly, dealt in further detail, and chiefly from the manufacturing point of view, with the evils caused by the presence of ammonia salts in cells, which the author drew attention to in a paper read before the society in July of last year. The principal evils ascribed to the presence of ammonia or nitrogen salts are loss—sometimes excessively great loss—of capacity and normal fall of the specific gravity of the electrolyte during discharge, with failure to rise correspondingly during charge, and thus leading to either systematic overcharging, with much shedding of active material, or else systematic undercharging and expansion and buckling due to sulphating. Mr. Vicarey, however, does not deprecate the use of nitrogen compounds in the formation processes; on the contrary, he recommends it as assisting in the oxidising of the positives, causing them to acquire a good rich colour, and effecting economy in production. But he lays great stress on the importance of entirely eliminating the last traces of nitrogen before the plates leave the works, and he points out how very difficult it is to bring about this complete elimination unless extreme care is taken by the manufacturer. This is particularly the case where the completion of the formation processes takes place not in the works, but where the cells are to be used, and the result often is that the plates are never in proper working condition, as the following experiences are likely to be met with: excessive periodic shedding of PbO_2; abnormal heating of the forming electrolyte which sometimes causes breakage of the cells; heavy deposits of spongy lead on the negatives or dummies; and abnormal growth of the positives (in one case quoted to the extent of an inch or more) during formation. Finally, Mr. Vicarey states that the presence of nitrogen leads to the formation of a particularly obdurate and irreducible (as if $PbSO_4$ were not bad enough!) lead sulphate, which he states to have the composition $2\,PbSO_4.PbO$. The announcement of the existence of this sulphate was received with some scepticism by several of the speakers at the meeting, and it would be well if Mr. Vicarey were to put forward such data, including the physical constants of the new sulphate asked for by Mr. Joly, as would confirm the existence of this hitherto-unobserved salt.

The most interesting, as also the most satisfactory, portion of Mr. Vicarey's paper was that section dealing with the accentuation of the evil effects of ammonia when a metallic impurity is likewise present in the electrode, and he describes a series of voltameter experiments made with platinum electrodes (lead would have been more to the point) in dilute sulphuric acid containing varying proportions of ammonia and iron, both singly and together. The results are given in the form of percentage losses of gases evolved due to the impurities present, and it is therefore somewhat difficult to make exact deductions from them that will bear directly on accumulators, but assuming the results are merely comparative, they show that the combined effect of ammonia and iron is very considerably greater than the sum of the effects due to each singly, and this is even more strikingly the case when low current densities, such as are used in ordinary accumulators, are employed. Now iron is a very common impurity, both in ordinary water and in ordinary sulphuric acid, and in drawing attention to the possible evil effects of its presence, especially when in conjunction with nitrogen or ammonia, Mr. Vicarey has done useful service both to the manufacturer and to the user. But it is possible to ride to death even a true hypothesis, and it is to be hoped that Mr. Vicarey will render his work still more useful by enlarging the experimental basis on which his hypothesis rests, and doing this in so exact and definite a manner that the possibility of drawing any wrong conclusions will be reduced to a minimum. He will then no longer have to fear lest manufacturers or intelligent users of accumulators heed not his timely warnings.

LEGAL.

Workmen's Compensation.

An important decision as to when a man is on or off duty was given at the Darlington County Court on Wednesday last week, by his Honour, Judge Templer. Mrs. Emma Archer, widow of Enoch Archer (night foreman at the Darlington Corporation electricity and tramways department) sued the Corporation, under the Workmen's Compensation Act, for compensation for the loss of her husband. On September 6th, Archer (who was on duty from 11 at night until 8.30 a.m. at the works), was walking along the main street at noon, when he noticed that an overhead pull-over switch was broken. Without waiting for instructions, he borrowed a ladder, and set about remedying the defect, but a "flash" caused him to overbalance, and he fell to the ground fracturing his skull, and dying almost immediately.

Mr. Gowan Taylor, barrister, on behalf of the widow, contended that Archer's terms of engagement were such that he was liable to be called on at any moment in case of emergency, and, therefore, was practically always on duty. The Compensation and Guarantee Fund, however, had denied liability. He called several witnesses, including Mr. F. W. Hewitt, assistant electrical engineer to the Corporation, who stated that Archer was under a moral obligation to do the work, though the fatality would not have occurred if he had used the tower ladder instead of an ordinary ladder.

Councillor Wooler (chairman of the Tramways Committee) said when Archer saw anything wrong, it was his duty to put it right, with or without instructions. Otherwise, there might have been a serious breakdown.

Mr. C. J. O'Dowd, traffic manager, held that Archer was justified in taking the initiative to put anything right that he saw was wrong, and would be expected to do so.

Mr. Atkinson, of Manchester, who appeared for the respondents, argued that the accident did not arise "out of" or "in the course of" Archer's employment. It would have been very easy for the Act to say "while working in the interests of his employer," but it did not do so. There was an immense difference between a man working on instructions and doing work voluntarily. When a man acted without the knowledge of his employers, they had no chance of minimising the risk, and a duty could not be imposed on employers when they were absolutely ignorant of the fact that work was being done.

His Honour said he was absolutely against Mr. Atkinson. He thought Archer was acting "in the course of" his duty. In his judgment there was absolutely no defence to the action. There would be an award for the applicant for £300, with costs on Scale C.

Mr. Gowan Taylor, in reply to Mr. Atkinson, said he would give the usual undertaking as to costs if they were paid in.

Theft of Electrical Energy.

At Spennymoor, Durham, on the 13th inst., a miner named George Davidson was fined 40s. and costs, or 14 days' imprisonment, for having stolen a quantity of electrical energy valued at 1s. 6d., the property of the Northern Counties Electrical Supply Co. It was stated that, by inserting a piece of wire in the meter, the accused had obtained the current without its having passed through the meter.

Attorney-General *v.* Mersey Railway Co.

This case was mentioned in the Court of Appeal on Friday as to the undertaking the defendants were prepared to give so as to carry out the judgment of the Court delivered on December 4th. The question raised by the appeal was whether the defendants were entitled to carry on as ancillary to its railway undertaking the business of omnibus proprietors.

Mr. Upjohn ultimately agreed to an undertaking in the following terms:—"To run their omnibus service as a service for railway passengers, and so far as reasonably practicable to confine their service to passengers to or from some or one of their stations."

Counsel proceeded to submit that on this undertaking there should be no injunction, and consequently no costs. A public, or quasi-public service carried on in accordance with the undertaking, would be quite *intra vires*. This was an attempt by the proprietors of the ferry to crush the proprietors of the railway.

Mr. Cripps: Nothing of the sort.

Their Lordships discharged the order of the Court below except as to costs, and in consideration of the undertaking granted no costs of the appeal.

Action for Damages.

The Kent Electric Power Co. were the defendants in an action at the Rochester County Court on Thursday last week, when Albert Arthur Goodey, of Chatham, sought to recover £10 from them for personal injuries and damage to clothes and a bicycle, which, he said, were brought about through the defendants' negligence.

The plaintiff's case was that he, whilst riding down Strood Hill, Rochester, on July 1st last, on his cycle, was thrown through coming into contact with loose earth and stones which had been left by the company's men in the road after opening the same for the laying of mains.

Mr. Norman (Norman & Stigant, solicitors to the company) denied all liability, as the company had passed the roadway (by a prior arrangement) over to the Rochester Corporation authorities, and paid them for putting the road in the proper condition.

This would have been a close question, but on hearing the evidence, Judge Shortt was able to give his judgment in favour of the defendant company, simply on the facts as related without recourse to the legal point raised.

His Honour ruled that the plaintiff had failed to prove that the actions of the defendant company had caused the accident, and gave judgment against the plaintiff, with costs.

The company, however, did not ask for costs against the plaintiff.

A Dudley Tramway Claim.

At Dudley County Court last week, Judge Howard Smith and a jury were occupied six hours in hearing a case in which Harry Darley, "Royal Oak," Blackheath, sued the Dudley and Stourbridge Electric Tramway Co. for £31 odd damages to a brake, horse, and driver. The facts as related were these: On September 9th one of plaintiff's brakes was used to take a party to Stourbridge. Returning through Netherton the vehicle collided with one of the company's tramcars, one of the horses being killed. It was alleged, on the one hand, that the motorman was reckless, and on the other hand, that the plaintiff's driver was drunk. The jury decided that there had been negligence on the part of the company's servant, but for which the accident would have been avoided, and they gave plaintiff a verdict for £21.—His Honour remarked, however, that the verdict was contrary to the weight of evidence, whereupon Mr. Waldron, solicitor on behalf of the company, applied for a new trial, and the Judge granted the application.

Manchester Tramway Claims.

The Manchester Corporation last week defended two actions for damages, which were brought against it in the Manchester County Court. The first was an action for personal injuries and damage to a horse and cart, resulting from a collision. The plaintiff, a carrier named Wright, said he was turning out of Stretford Road, into Medlock Street, when an electric car knocked his horse down and broke his cart shafts, he himself being pitched into the roadway. The judge was of opinion that the plaintiff had not himself used proper care, and gave judgment for the Corporation.

In the second case the verdict was the same. The plaintiff was a Middleton carrier, who claimed £7 17s. for damage to his horse through a collision. The judge, after hearing his evidence, told the plaintiff that he had no case.

CORRESPONDENCE.

Letters received by us after 5 p.m. on Tuesday cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Newark Electricity Supply.

My attention is called to a paragraph relating to "Newark" in your issue of 14th inst., in which you remark that "Mr. Vesey Brown was asking for payment on account for preparing the schemes."

I do not know that it requires a public disclaimer, but for your own information, I may say that I never asked the Newark Town Council for anything on account of my work. They quite acknowledged their indebtedness to me, and I should not like the impression to be made that either they or I were at all impatient on this question.

I was treated in a very courteous manner by the Newark Town Council throughout the whole of the negotiations with the D. and N.E.P. Co., and regret that your paragraph should ever hint at the possibility of any disagreement or delay on the score of payment to me. As to the policy of the Town Council in wishing to obtain a supply "in bulk," I think they are quite right in holding off until they get it, and though the delay is serious to some people, the policy is a right one, and no doubt they will at some future date be in a position to make terms for such a supply which will be more advantageous to the town than if they had carried out the work themselves.

C. S. Vesey Brown.

Newcastle-on-Tyne,
December 17th, 1906.

[The statement that Mr. Vesey Brown "was asking for payment on account," in no sense reflects discredit upon him; but, of course, in view of his denial, we unreservedly withdraw it, with regret that it has caused him any annoyance. Our note was intended to draw attention to the vacillation and indecision which are characteristic of such bodies as the Newark Town Council, when dealing with matters with which they are not conversant.—Eds. E.R.]

Commutator Lubrication.

I think "Electra" would have a great many friends if we all wrote our troubles on "Commutator Lubrication." I have tried several makes of "carbon brushes," and have used paraffin wax, beeswax and other lubricants, but I have found none of them satisfactory. However, I have got over the above difficulty. We have been supplied with a special brush by Messrs. Reid, Ferens & Co., of Newcastle-on-Tyne, which has been in use now for 10 months, the commutator and brush having a very smooth surface, and the commutator only needs wiping once in 12 hours. This brush has a great advantage over the ordinary "carbon brush" both in the life of itself and commutator. The above are on a 200-kw. generator, which is only standing three hours in the week.

Electric.

I am in agreement with your correspondent "Electra" *re* the use of lubricants on commutators with carbon brushes.

Personally, I have found that it pays to keep oils or grease of any description away from such commutators.

Lubricants are used as a rule to prevent undue noise and vibration, but where noise is due to heating of the commutator, the difficulty can often be met by changing the quality of the brushes.

If the design of the machine permits graphite brushes to be used, they will generally be found to keep down the temperature and to prevent noise altogether.

Paraffin wax is all very well when the commutator is comparatively cool, but when it is hot, any wax eventually becomes carbonised and causes partial shorts between adjacent segments.

Vaseline or wax, when driven off by a very hot commutator, also gets drawn in between the end connections, and causes far more copper and carbon dust to adhere to the windings than would otherwise be the case.

I have known no fewer than three cases where flashing over was traced to the use of too much lubricant.

There seems to be a growing tendency amongst manufacturers to keep down the dimensions of the commutator as much as possible, and on some multipolar machines the clearances are often so small that it does not require much to cause the machine to flash over.

With reference to the cleaning of the commutator, I prefer to use a spirit, such as benzine, and to clean while the machine is warm.

If vaseline is allowed to remain on the commutator, it sometimes penetrates between the layers of the mica and becomes carbonised there, the only remedy then being to turn the commutator up.

A. S. H.

Commutator Insulation Defects.

We have noted with considerable interest the report by Mr. M. Longridge, in your issue of 9th ult., on "Breakdowns of Machinery in 1905." The portion of the report which especially interests us, is that having reference to the employment of micanite in motors in the commutator segment insulation.

Your correspondent, Mr. A. E. Vickery, in his concluding paragraph, very happily suggests a prominent cause of failure, whilst the letter of the Mica Insulator Co. rather gives one the impression that they are on the defensive in respect to their material. We would remind them of the proverb, "Qui s'excuse, s'accuse." There are, of course, other "largest suppliers" of micanite and pure mica to whom this subject is also interesting, but electrical engineers are to blame for their not over careful discrimination between different manufactures, and for mostly allowing the question of a few pence per lb. in the price to influence them in the choice of a material, which may give them serious trouble.

Mr. Longridge's report does not make it clear whether out of the 100 cases the remaining 37 cases of breakdown were due to the failure of pure mica insulated commutators. If so, in view of 90 per cent. of machinery over 2-3 H.P. being at the present day insulated with assembled pressed mica, the 37 would show badly for "pure" mica insulated commutators.

Without a doubt a large percentage of breakdowns are caused, as Mr. Turner points out, through dirt and oil, especially the latter, the process being as follows:—

Mica—the so-called "pure" mica—as well as the assembled pressed mica—possesses in a high degree great electrical capacity, as even at low voltages electrical discharges into the air take place. Oil is distinctly a better insulator than air, and as soon as it comes into contact with the mica it prevents the electrical discharge, which is converted into heat and causes an erosion of the mica segment until a circuit is formed between the copper segments.

This process can be verified in the laboratory with great certainty. It is sufficient to place a drop of oil on a piece of mica and electrify it at a low voltage to produce a short circuit.

As the representatives of a very important firm of insulation manufacturers, we desire to emphasise this to the extent of saying that the cause of the breakdown lies in the machine itself, for oil does not dissolve the adhesive material, which as far as our product "Megohmit" is concerned, does not practically exist, and hence our material consists of what may be termed "pure mica," though in an assembled form.

The selection of proper materials for electric construction is all-important, and if discrimination in the selection of a proper material for commutator insulation is exercised, a great factor in breakdown will be removed.

We apologise for the length of this letter, and for the delay in taking up the subject on which we hope the correspondence is not yet closed.

Geo. Schultz & Co.

London, E.C., *December 13th*, 1906.

In reference to "Commutator Insulation Defects," I may say I quite agree with Mr. Longridge and Mr. Sheppard that pure mica, and not micanite, should be used for commutators. I have had some trouble through breakdowns, on two machines of late, and cannot in any case find the trouble due to oil, or any other cause, except the micanite. I have not tried either of the mixtures mentioned, but intend doing so, and will let my fellow readers know the result. I think it is a very interesting subject, and should like to hear some more opinions.

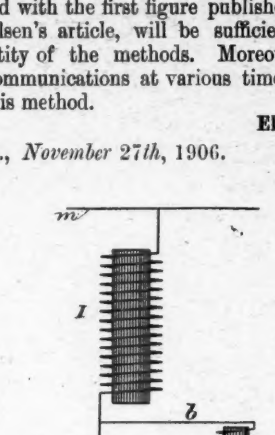
Mica.

The Production of Undamped Oscillations.

In your issue of Friday, November 16th, 1906, under the title of "Wireless Telegraphy by Means of Undamped Oscillations," there appears an article by Mr. Poulsen. I deem it my duty to point out that the method of producing undamped electric oscillations was discovered and practised by me about 15 years ago, and was described in U.S. Patent No. 500,630, which was issued on July 4th, 1893, and which had been applied for on July 18th, 1892. I am sending a copy of the patent herewith, the first figure of which, when compared with the first figure published in connection with Mr. Poulsen's article, will be sufficient to show the practical identity of the methods. Moreover, I have in articles and communications at various times alluded to the existence of this method.

Elihu Thomson.

Lynn, Mass., *November 27th*, 1906.



Excerpt from Specification.

In fig. 1 *m n* may represent mains or wires from a source at a difference of potential of, say, 500 volts. The circuit connecting them includes at I a coil of many turns wound upon an iron core, preferably of iron wire or laminated iron.

At G is a discharger consisting of two balls or terminals of brass or other such metal, the distance between which can be adjusted.

At K is a condenser, the capacity of which may be made variable and the connection to which may be said to be shunt to the gap G.

At H, if desired, is included a coil of more or less turns or of more or less self-induction, in circuit with condenser K around the gap G.

At M is represented a powerful magnet, which is not always, however, necessary, but the purpose of which is to break any arc between the balls at G. It may sometimes be replaced by an air jet.

To operate the apparatus, the balls at G are first made to touch or a switch around them might be arranged to complete the circuit. Then the balls are separated or the switch opened, and with an adjustment of the gap at G so as to obtain between the balls an apparently continuous discharge. A little care in the adjustment soon determines a condition of charge and discharge of the condenser K, as follows:—The separation at G tends to stop current passing thereat and to divert it to the condenser K, and while this is charging the arc or spark is extinguished at G, as the self-induction I has limited the current from increasing to an amount sufficient to keep up the discharge at G while still charging the condenser K. The charging of the condenser K takes place in a very short space of time and is attended with such an increase of potential from its two sides that, owing to the self-induction tendency or constancy of the feeding current, a spark or discharge again leaps at G, and the condenser at once discharges. The rupture of the spark or arc at G follows immediately, the condenser again charges, accumulates a potential sufficient to leap again, and so on.

It will be seen that that portion of the circuit represented by *b b* will, during the action just described, be subjected to alternations of current, as will also that portion H which represents a self-induction or coiled portion. Unless the capacity of condenser K be relatively very great or the self-induction of H be very great, these alternations or impulses will be of extreme rapidity, and I have obtained easily frequencies of thirty thousand or forty thousand, so far as can be discovered by estimation.

Conduit Trust.

Referring to "Contractor's" letter in your issue of 14th inst., is not the matter entirely in the hands of the contractors? There is a combination, and there are, we understand, two firms outside it, who apparently do not believe in combines or other Yankee devices. The contractors have it in their hands to place their orders with these firms at prices

based on the cost of materials, and not on artificial bolstering up by combination. If, however, they allow themselves to be cajoled into deserting these independent firms by quotations specially offered by the combination with the view of damaging these firms, and so compelling them ultimately to join the Association, then they will only have themselves to thank if before long they find there are no makers left outside the ring. It seems hardly necessary to suggest that, in such case, as in every other ring or combine, they will have to pay very heavily in the long run for not supporting outside manufacturers.

Anti-Trust.

In reference to "Contractor's" letter in this week's REVIEW, we beg to say that we have entered the most practical protest in our power to the combine, by simply transferring our orders to one of the firms not in the ring, and expect that we are not the only ones who have taken this step.

Another Contractor.

Replying to "Contractor's" letter appearing in your "Correspondence" columns of the 14th inst., we think that possibly the following information may be of use to your readers.

As the representatives of the National Electrical Manufacturers' Association on the Engineering Standards Sub-Committee appointed for the purpose of standardising electrical fittings, meters, switchboards and accessories, we assisted in the preparation of a standard specification for electrical conduits and accessories, which was forwarded to all manufacturers of these goods, as it was felt that in order to bring about proper standardisation manufacturers must be as one in adopting the specification.

The result has been that the firms have agreed at considerable trouble and expense to supply standard material in accordance with the Engineering Standards requirements. This, no doubt, is what your correspondent, "Contractor," is alluding to. Hoping that this explanation may be of service to those interested.

F. H. Nalder.
C. S. Northcote.

London, S.W., *December* 18*th*, 1906.

A Study in Flex.

Referring to the letter of Mr. W. E. Lane on the above subject, it may interest you to know that similar instances of "flexible" troubles have occurred nearer home through practically the same cause. I can call to mind two instances in which sparking has been seen and shocks felt on the outside of the flexible used in pendants in a fish and poultry dealer's shop. This was entirely due to the lodgment of flies and the fishy slime that collected on the cord.

The remedy is obviously the employment of a brass or other metal suspension tube in such situations.

E. E. Putland, A.M.I.E.E.

Catford, S.E., *December* 17*th*, 1906.

Tungsten Lamps.

Referring to a letter signed "Efficiency" in your current number, your correspondent may probably be referring to the lamp invented by Dr. Kuzel, whose representatives we are.

If such be the case, we may state that these lamps, although they are being manufactured at the present time, are not yet on sale in any of the European countries. It is probable, however, that they may be on the English market in the course of the next three months.

Fahn & McJunkin.

London, W., *December* 14*th*, 1906.

The Tungsten, or, as the Germans call them, Wolfram lamps referred to by "Efficiency" in your issue of last week, are probably the Zircon Wolfram lamps which are being introduced into this country by us. At present we are unable to supply, as the English makers are not yet ready, but we shall shortly be able to get lamps from Paris, Brussels and Vienna.

The Berlin works cannot supply one-fifth of the lamps now on order.

The Zircon Syndicate, Ltd.
P. F. STEVENS, *Secretary.*

London, E.C., *December* 17*th*, 1906.

The Social Side of the I.E.E.

Referring to the correspondence which has appeared in your columns recently, I venture to suggest that the time has now arrived when the Council of the Institution should consider the advisability of utilising the plot of land, which they own in Westminster, for the purpose of providing a suitable building to be used, not only by the members of the Institution, but also by the various Electrical Associations, to which the Institution, one might say for the purposes of argument, is the parent. In other words, these various Associations would doubtless be willing to become tenants of a suite of offices, with committee rooms, &c., ample accommodation for which could doubtless be found in the new building.

And again, I think that a portion of the premises might be set apart also for an Electrical Club. Members would then be able to fraternise freely, for, as mentioned, the annual dinner is practically the only opportunity that is afforded them for so doing.

If some such arrangement cannot be come to in the near future, I suggest that an Electrical Club be formed, and I for one shall be willing to take an active part in bringing it about.

C. S. Northcote.

London, S.W., *December* 18*th*, 1906.

[We are pleased to insert this letter, and hope that the matter will be carried to a successful issue.—EDS. E.R.]

A Question of Compounding.

I should esteem it a great favour if someone would oblige me with the benefit of his experience in a similar case to the following:—It is proposed to enlarge a plant consisting of 220-volt generating sets, all compound wound, arranged on either side of a middle wire to give a 3-wire supply with 440 volts across the outers. If the additional set be a 440-volt one, also compound wound, will there be any difficulty in making it take its proper share of the load?

Midland.

The Qualifications of a Shift Engineer.

Mr. Milnes has very fine ideas as to the qualifications necessary for a shift engineer, but has he considered the cost of obtaining the training and experience and the reward to be expected? I have gone through the course almost as outlined by him, and the cost has been roughly as follows:—

Premium	£100
Personal expenses, four years as apprentice at (say) £50 per year	200
Personal expenses, two years as improver and and switchboard attendant at about £25 per year	50
Fees, books, instruments, &c., for technical training (at least)	50
Total (at the lowest estimate)	400

I make no mention of the hardship entailed by a young man giving up his evenings to classes and home studies, after being at work at 6 a.m.

In return for this one may expect an appointment at 30*s.* per week if one is lucky enough to be picked from the heap of applicants.

Then he may be one of 300 for a post as chief assistant at £120 per annum. If lucky enough to get it, he may settle down until someone dies, and there is a general shuffle of chiefs.

Other interesting points, such as seven days per week, working 12 hours per day for a month to get a fortnight's holiday, &c., have been too often brought up in your columns to need mentioning.

E

I have come to the conclusion that the game is not worth the candle, and, unless I am in a spiteful humour, I advise any friend who had an idea of entering the business to train as a road sweeper, or some such profession, instead.

D. E. McDonnell.

Electricity Works, Bray,
December 14th, 1906.

Rail Corrugations.

I think, with Mr. H. Thom, whose letter on the above subject appeared in last week's ELECTRICAL REVIEW, that Mr. Yerbury is on the right tack in attributing corrugations to defective rolling mills, possibly brought about after excessive or too prolonged use. I am acquainted with a tramway, the rails for which were amongst the first lot to be made after the girder fashion, consequently the mills which made them, may be considered to be almost new, and to be in good condition. Electric cars have been running over the tramways referred to for a period of 10 years, and no corrugations have yet appeared. Yet in the same town, on other routes which were made five years later, corrugations have appeared in abundance. Should not rolling mill proprietors be made to pay for the serious losses brought about by corrugations?

Tramway Manager.

December 15th, 1906.

Your correspondent Mr. Thom, if he wishes to discover the real cause of rail corrugations, should examine the process of manufacturing steel at its inception. It is well known that Bessemer steel as now manufactured, in its carbon contents throughout the mass is seriously irregular, and for this reason and the law of the survival of the fittest, it is being gradually displaced by steel made by the open hearth process, which, although far from perfect, is more regular in its carbon content.

The irregularities of both steels are aggravated by the ordinary methods of casting the ingots, which increase still further the carbon proportion irregularities throughout the mass.

The mechanical treatment, finishing with the rail rolls, produces irregular carbon contents along the length of the rails, and there are corresponding degrees of hardness and softness—hence the formation of the corrugations. A drop or impact test on many of the Bessemer rails now in use would produce some astonishing results.

Rail Steel.

Metallic Filament Lamps Wanted for Street Lighting.

Many station engineers are, no doubt, anxiously awaiting the advent of a metallic filament lamp of high candle-power for street lighting purposes for voltages up to 250. Lamps are now on the market for voltages up to 130; where then is the difficulty in doubling the length of the filament, and using larger bulbs? A lamp of 100 C.P. would be the most useful size, and would allow the filament to be a little more substantial than those in lamps at present in use.

Perhaps the makers will give us some idea as to whether these lamps are shortly forthcoming; I am sure that as soon as they do appear, they will sell like hot cakes.

A Station Engineer.

Electricity Supply on the Rand.

If storage on the Rand is to be a feature of the proposed scheme for utilising the power of the Zambesi Falls, may I point out that it would involve a very much smaller capital outlay, and would give a very much higher efficiency, if electro-thermal storage were employed in place of the hydraulic. I need hardly remind your readers that heating by electricity has been developed very largely in many directions during the last 10 years, and that its efficiency is very high. I think I should hardly err on the wrong side if I took the efficiency of a system of electro-thermal storage as 80 per cent., while that of hydraulic storage could hardly exceed 50 per cent. As it should be possible to raise the temperature of a body of water, under the conditions that would rule, some 250° F., I make out that where some 1,600 million gallons of water would be required with the hydraulic system for the storage of 50,000 H.P. for 12 hours, a quantity of water that could be carried in a battery of Lancashire boilers would answer with the electro-thermal system. I need hardly remind your readers, either, that thermal storage has been successfully carried out on the system introduced by Mr. Druit Halpin and Prof. Rateau, using steam as the source of heat, and that it is a short step from that, and from existing electro-thermal apparatus, to the one I suggest. It is quite true, of course, that details will have to be worked out, and the idea may possibly come as a little startling to those who have not considered the matter; but it is hardly more startling than the proposal to deliver the energy of a waterfall at a distance of 700 miles on to a coalfield, and the details that will have to be worked out, I venture to say, will not be so difficult as those involved in delivering the large amount of power named over 700 miles, at 150,000 volts.

Sydney F. Walker.

Bath, *December 17th*, 1906.

With reference to a statement contained in a letter from Mr. Wilson Fox, dated the 10th inst., that the Rand Central Electric Works, Ltd., had made statements during the last six months that it was placing orders, and that so far nothing had happened, I am instructed to say that an order for turbo-generators of a total capacity of 7,500 H.P. has been placed by the Rand Central Electric Works, Ltd., with my company.

W. H. Stafford, *Secretary*,
SIEMENS BROS.' DYNAMO WORKS, LTD.

London, S.W., *December 13th*, 1906.

Nernst Lamp Renewals.

We welcome the letter signed "P. A. S." as showing to your other correspondents that Nernst lamps will do everything we claim for them if they are properly treated. None of the writers of previous letters has, we believe, had anything like the same number of lamps in his charge, and not one seems to have watched and attended to his lamps in the same thorough way. There is little that requires attention in a Nernst lamp. The lamp must be matched for the proper voltage, and all parts must be for the same amperage; it must, on direct current, be connected to the right polarity, and its cut-out must be looked after occasionally; and if it is found faulty, the body of the lamp must be returned to us for repairs. Very often one or all of these three simple precautions are neglected, with the result that many burners fail to give a fair average life, and cause great loss and annoyance to our customers.

The following are three typical complaints we recently had occasion to investigate:—

1. *Street Lighting Installation of* 70 ½-*ampere A Lamps.*—Complaint: Average life far too low. Result of examination: 32 lamps wrong poles, eight lamps faulty cut-outs. (The engineer-in-charge had repeatedly assured us that every single lamp was properly poled.)

2. *Shop Lighting Installation of* 24 *A*, 30 *B and* 4 *Multiple Lamps.*—Complaint: Burners often fail after five to 10 hours' use. Result of examination: 220-volt burners used with 20-volt resistances on a circuit with a maximum voltage of 232. The cut-outs, of course, could not switch off the heating circuit, and the result was that heaters failed. Remedy: 210-volt burners and new cut-outs.

3. *Factory Installation of* 40 ½-*ampere Luna Lamps and* 8 *Multiple Lamps.*—Complaint: Burners absolutely unreliable; some last 700 and 800 hours, others last hardly a minute. Result of examination: seven lamps with wrong polarity, nine lamps with one-ampere resistances, causing ½-ampere filaments to fail, and three lamps with faulty cut-outs, causing heaters to go.

Of course it would be absurd for us to say that every one of the millions of burners that leave our factory is perfect. We have had bad batches, and in spite of extensive testing and checking arrangements, faulty burners cannot be entirely

avoided. Such burners, however, constitute considerably less than 1 per cent. of our entire production, and our customers will always be liberally met when the fault does lie with the burners. For their own satisfaction, however, users should, before condemning the lamps, make sure that the trouble is not due to one of the above causes, which are responsible for 75 per cent. of the failures.

In conclusion, we would say that we shall always be pleased to examine and report on Nernst lamp installations which do not give satisfaction.

A.E.G. English Manufacturing Co., Ltd.,
Patentees of Nernst Lamps for U.K. and Colonies.

London, W.C., *December 15th*, 1906.

Your correspondent "P. A. S.," considers my remarks on the 1-ampere Nernst lamp to be "damaging and unwarrantable." "Damaging," in a sense, they were intended to be, and I hope they were; as I am of opinion that the 1-ampere lamp—both "A" and "Luna" type—is not a success. That they are "unwarrantable," I deny. "P. A. S." is not the only user of Nernst lamps who has had to go carefully into the causes of failure; and I think I need only state that I have used ½-ampere Nernst lamps for street lighting since January, 1903, have nearly 100 of these lamps for this purpose, and have had—as I stated in my letter—"fairly good results," to show that I have not been content with putting in new glowers as they fail.

I repeat, however, that "the 1-ampere lamp is here, and, I believe, elsewhere, an unmitigated failure." Of their being a failure here, I have absolute proof, and as to their behaviour elsewhere, I have abundant testimony. In fact, I was told, not long ago, by a chief representative of one of the leading firms dealing in Nernst lamps, that he never recommended 1-ampere lamps. Although I, myself, have no desire to hide behind a *nom de plume*, obviously it would not be fair to mention the name of this gentleman.

In conclusion, I would suggest that it is not in the true interest of electric light to adopt the ostrich-like policy of hiding our heads in the sand, so as not to see the defects of any electrical apparatus. Our friends the enemy—of the gas undertakings—will not come to us for evidence of the superiority of gas lighting, any more than we go to them to discover the shortcomings of inverted burners, high-pressure gas lighting, or poisonous gas stoves.

A. C. Hanson,
Burgh Electrical Engineer.

Stirling, *December 17th*, 1906.

The Channel Falls Scheme.

I do not know whether the approaching Christmas festivities are already having an effect on the Press, but I observed this morning, going to work, the announcement on the poster of a well-known morning paper, "Channel Tunnel Wanted," and on reaching my office I found a special issue of the *Times* awaiting me containing the prospectus of "The Channel Tunnel Co." As it is not quite clear whether this issue of the *Times* is a private communication or an advertisement, I think, perhaps, those of your readers who may not have received it will be interested to learn the leading proposals of the new company.

The share capital (I quote now from the prospectus) is to be £20,000,000. The immediate provision of a cross-channel service being the most important consideration, it is proposed to build, in the first instance, a fleet of 12 turbine boats, which will keep things going during the construction of the tunnel, and will serve as a reserve in case of breakdown when the tunnel is in operation. The existing demand for transit facilities, on the assumption that the company will take over between 80 and 90 per cent. of other companies' traffic, fully justifies the creation of this new fleet, and it is believed that phenomenal extensions may be confidently anticipated as a result of the *entente cordiale*. Contracts have been entered into with all the leading English and French municipalities to use the company's route exclusively for all official visits.

The construction of the tunnels will nevertheless be commenced at once. It has been decided to build two tunnels side by side from Dover to Calais. It is not, however, proposed to utilise both of these tunnels for traffic, but one will be held as a subsidiary reserve which can be brought into operation should the first tunnel break down, and be used for a period of 12 hours or less during which the reserve fleet of ships are being repainted and fitted for service. In order to ensure the secondary tunnel being maintained in working order one train will be sent through it daily. A contract has been entered into with the Government to consign all rejected aliens by this route.

A third, much larger, tunnel will also be constructed. This will be connected at every mile to the other two tunnels by drain pipes, and will be entirely fitted with best Turkey sponges. The two traffic tunnels will be provided at intervals of a mile with water-tight dividing doors operated electrically. Should a leak occur in either tunnel the water will flow from it into the "sponge" tunnel; this will produce a diminution in the electrical resistance of the sponge-line which will automatically bring into operation the door-closing apparatus, closing the doors on either side of the leak, and thus saving from destruction all trains except those actually in the faulty section. The full patent rights of this invention have been secured by the company.

The directors anticipate considerable development of local industries, the sea bottom abounding in fish, coral necklaces and other commodities, and stations will be erected along the route to encourage this traffic, which may be relied upon, in time, to bring in considerable revenue.

Power will be obtained from the Falls of Lodore in the English Lake District. As the British Government have refused wayleaves for aerial lines across England, the conductors will be carried on poles round the coast just outside the 3-mile limit. Contracts have been entered into with the British Admiralty to patrol the transmission line, and with the Marconi Co. to transmit, *via* Montenegro, immediate information of any breakdown.

The South-Eastern and Chatham Railway Co. having made it a *sine quâ non* that all trains shall be at least 1½ hours late, special submarine Chinese pavilions will be constructed 3 miles from the English coast, where out-of-work members of the House of Lords have kindly consented to entertain passengers of any trains which may make the crossing in scheduled time.

The fares will be fixed at 60 per cent. of ruling prices, and it is estimated that the average fare per crossing will be 3s. 9d. The capital charges per passenger per journey are estimated at £1 12s. 6d., and the working expenses at £1 7s. 6d. It will, therefore, be seen that there is a considerable deficit, which is the reason the public are now asked to subscribe. The public are asked to make provision for the future by investing at once in anticipation of the handsome profits which the development of the submarine industries will, no doubt, one day bring in.

The President of the Board of Trade will open the tunnels on the first day of April, 1909.

Applications for shares should be made at once to the *Times* Book Club, who reserve the right to sell same at second-hand prices immediately after allotment.

Can any one say, after reading this summary, that English engineers are lacking in enterprise?

A Prospective Investor.

Birmingham, *December 12th*, 1906.

INQUIRIES.—"Nemo" would like a recipe for making up the enamel used for bedding heating apparatus and rheostat wires.

"OUTIS" inquires for a cement for joining short lengths of arc lamp carbon.

TO CORRESPONDENTS.—A number of letters are unavoidably crowded out.—EDS. E.R.

Blackmore's Dead Wiring.—We understand that this system has been adopted in connection with an electric light installation recently carried out at Sudbury House, Harrow-on-the-Hill, N.W., by MESSRS. W. K. PARTINGTON & Co., of 28, Minories, E.C. The lights on the columns along the carriage drive from the lodge and stables to the house are manipulated by push-buttons in parallel, in order that the lights may be controlled either from the main entrance gates or from the house. Messrs. W. K. Partington are carrying out another installation at Lingfield, Surrey, where also they are introducing this system of control.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

B.T.-H. Heating and Cooking Apparatus.

A series of attractively got-up little pamphlets describing their heating and cooking devices will shortly be placed in circulation by the British Thomson-Houston Co., Ltd., of Rugby. For the

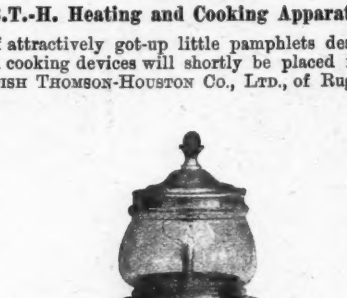


Fig. 1.—Electric Tea and Coffee Percolator.

B.T.-H. apparatus there is claimed the practical indestructibility of the heating unit; no solder is used in making any of the vessels, with the result that they will stand considerable over-heating without damage. In fig. 1 we illustrate the company's electric tea and coffee percolater, which is neat in appearance and which can

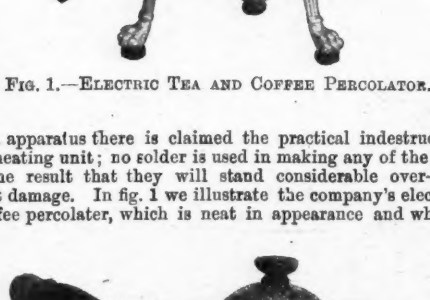


Fig. 2.—Electric Chafing Dish.

be connected to any ordinary lamp socket. It is made with a removable electric heating element of the "Q" type insulated, and is of polished non-tarnishing aluminium on the outside and tinned-copper inside. Fig. 2 represents an electric chafing dish

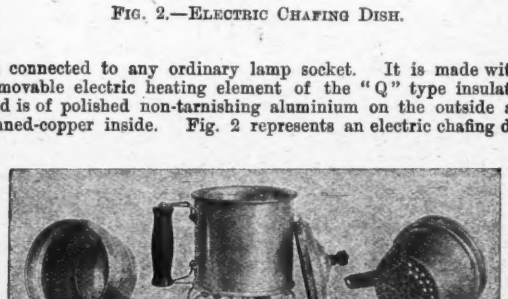


Fig. 3.—Parts of Combination Cereal Cooker.

(aluminium polished outside, and sheet copper-plated inside). The heating element is arranged for two heating, and the dish is adapted for either hot water or direct heating. In fig. 3 we show a combination cereal cooker disassembled, which is made in quart (single heat) and two-quart (three-heat) sizes. The quart heater may be attached to any lighting circuit, and may be used as a liquid heater, an egg boiler, or milk warmer. It is supplied in two styles, with and without combination attachments, consisting of vegetable steam and cereal cooker (or double boiler). The two-quart size may also be connected to the lighting circuit, but it requires a suitable branch and switch; the three heats are controlled by an indicating switch conveniently mounted, or the device can be furnished with two connections, one for high and one for low heat, which is obtained by changing the detachable connector

Fig. 4.—Electric Glue Pots.

from one to the other. Another of the new B.T.-H. devices is shown in fig. 4, which represents a line of electric glue pots or sealing wax melters. Yet others, which are described in the booklets, are electrically heated flat-irons for the rapid drying of blue prints, three-heat electric ovens, frying pans, grids and broilers, and complete cooking outfits.

BUSINESS NOTES.

Osmi and Osram Lamps.—We have received numerous inquiries of late respecting these new lamps, and it may be of interest to many of our readers to learn that the difference between the Osmi and Osram lamps lies chiefly in the efficiency, the former taking about 1·7 watts per British normal c.p. and the latter about 1·3 watts. Osram low-voltage lamps are being supplied for voltages from 2 to 25, these being parallel lamps which the makers changed over from the Osmi to the Osram type about six months ago. Osmi lamps of this range are no longer manufactured.

Osmi lamps suitable for voltages from 30 to 77 are manufactured, and can be obtained for 16, 25 or 32 c.p. (Hefner). The makers have, we understand, decided to bring out a type of lamp called the "Osram-O" lamp, which is interchangeable with the above Osmi lamp. Particulars respecting the efficiency, &c., of these are not yet available.

Osram lamps suitable for lighting circuits of 100 to 130 volts are now being manufactured, and as these are more likely to meet general requirements in view of their suitability for use on 100-volt mains, a little more detailed information respecting them is of interest. The Osram lamp is stated by the makers to have an inefficiency of about 1·1 watts per Hefner c.p., or 1·3 watts per British normal c.p. The lamps can be supplied for 32, 50 or 100 Hefner c.p. We understand the average life to be about 1,000 hours, and the decrease in c.p. at the end of this period is stated to be about 5 per cent. The lamp must only burn in a pendant position, and must not be erected at an angle or upright. This is due to the fact that the filament, when incandescent, becomes very soft. It is expected, however, that the difficulty in running the lamps in any other than a pendant position may shortly be overcome. Two lamps can be run in series on 200-volt circuits and upwards, but lamps for this purpose are specially made, and it is not advisable that ordinary lamps should be used for running in series, unless most carefully paired for current consumption; even this latter course the makers do not recommend. The Osram lamp is equally good for alternating or continuous-current circuits. Another point to be noted is that the filament in its cold state is exceedingly brittle, and the General Electric Co., Ltd., of 71, Queen Victoria Street, London, E.C., who are supplying both the Osmi and the Osram lamps in this country, will not hold themselves responsible for breakages which occur in transit. The company state that owing to the fact that the workshops are at present unable to cope with the large demand, they can only accept orders for execution in rotation. Those desirous of further information with regard to these lamps should apply direct to the General Electric Co., Ltd.

A Garden Suburb Scheme for the Midlands.—There is a scheme on foot for establishing a large model village on the outer fringes of Wolverhampton. It is proposed to carry out the scheme on an estate of about 400 acres two miles from the centre of the town, which lies at the high altitude of from 450 to 500 ft. above sea level. It is well timbered and picturesque in character, although a considerable part of it is within a mile of some of the largest industrial works in the Midlands. Sir Richard Paget, Bart., the owner of the estate, recognises the necessity of preventing the continued erection of crowded rows of dwellings, and desires to develop the estate on lines which will secure healthy and adequate housing accommodation for the inhabitants. The

design of the whole area is being prepared in advance, on what has come to be known as Garden City principles. It is also proposed to hold a Model Housing Exhibition on the estate in the late summer and autumn of 1907, when prizes amounting to at least £250 will be awarded for the best houses containing four and five rooms and erected at a cost not exceeding £250. Full particulars can be obtained from the secretary, Gresham Chambers, Lichfield Street, Wolverhampton.

The scheme is of special interest in view of the fact that the growth of Wolverhampton depends considerably upon the success of its electrical and engineering works, and the greater part of the population is employed in these industries or industries of an engineering character. The site to be developed is in proximity to the works of Messrs. Evans, makers of pumps, &c., the Electric Construction Co., the engine works of the G.W.R. and several other important concerns. We understand that it is proposed to make it a feature of the exhibition to offer prizes for the best method of utilising steel in the construction of houses and other buildings.

Catalogues, Calendars and Lists. — The *Chemical Trade Journal* has sent us, as usual, one of its hanging wall calendars for next year. It has monthly tear-off sheets.

The National Telephone Co., Ltd., Telephone House, Victoria Embankment, E.C.—The company is issuing a new sale catalogue, and the first five sections have come to hand. Section 1 (38 pp.) gives a great deal of information, with an abundance of illustrations, concerning their well-known metaphones for existing electric bell wires. A good deal of ingenuity has been displayed in producing these in forms studying the convenience of the user. Many useful diagrams of connections are given. Section 5 deals in the same high-class and interesting way with fire and police alarms and water-level indicators. Section 6 is devoted to descriptions of cement conduits. Section 8 describes electric fans; and Section 10 deals with telephone cabinets. When the later sections are issued it is intended that all shall be kept together in a binding case.

C. Lorenz Aktiengesellschaft, Berlin.—84-pp. catalogue in which they illustrate a great deal of telegraphic and telephonic apparatus which they are offering for sale in Great Britain and the Colonies. The particulars are conveniently arranged with code words and prices for each item. The company are very large suppliers of telegraphic apparatus to the German postal authorities.

The Sun Electrical Co., Ltd., 118-120, Charing Cross Road, W.C.—Fully illustrated and priced catalogue of their "Sun" incandescent lamps of ordinary shape, reflector and fancy patterns, by different makers. Tantalum and Turn-down lamps, "Sunlite" reflectors, and a cheap line in heat radiators are also listed.

Messrs. Richard Johnson & Nephew, Ltd., Bradford Ironworks, Manchester.—Priced circular relating to steel and iron wire, fencing and telegraph wire, &c.

Messrs. Johnson & Phillips, Ltd., Charlton.—8-pp. booklet briefly describing their Paterson's fireproof electric cables and wires, and giving a list of a number of places where J. & P. cables are in use in connection with public and private installations.

Messrs. Heap & Johnson, 28, Hatton Garden, E.C.—Circular giving some particulars regarding their "National" self-lubricating carbon brushes; illustrations of a number of regular forms appear, also a list of prices.

The *Brush Budget* for December has been issued. It closes the first complete year of publication, and the editor blames the Christmas season for the fact that some of his letterpress is "even more" irrelevant than usual. The many pictorial views of Brush manufactures speak for themselves, and that eloquently.

Union Electric Co., Ltd., Park Street, Southwark, S.E.—New list (No. 1,342) illustrating, describing and giving prices of their Kohinoor arc lamps. In regard to efficiency, it is claimed that this is very great, as with a 5-ampere lamp, it is said that the makers obtain 700 mean hemispherical c.p. measured with the ordinary globe on the lamp; it is also stated that it will burn for about 30 hours with a consumption of 11⅞ in. of carbon.

Messrs. Gibbons Bros., Ltd., Dibdale Works, Dudley, Worcester.—Four-page illustrated list, showing and pricing their iron and steel colliery tubs, tip wagons, conveyor buckets, light railways, &c.

Messrs. Hayward-Tyler & Co., Ltd., 99, Queen Victoria Street, E.C.—Pocket-book (87 pages) with leather covers and diary spaces for 1907. Some useful memoranda relating to water supply are given, these consisting of extracts from the firm's book on "Estate Water Supply." A copy of this pocket-book will be forwarded to any reader who sends his professional or trade card to the above address.

Adams Manufacturing Co., Ltd., 147, Queen Victoria Street, E.C.—First section of their 1907 electrical catalogue. It consists of a number of well-produced illustrated lists, giving particulars of the "Igranic" controlling apparatus for electric motors and dynamos:—multiple switch rheostat with interlocking switches, slow-speed gear for starting rheostats, full reverse motor-starting rheostats with automatic no-volt release, automatic self-starting rheostats for small and large motors, also self-starting rheostats for control of electric pumps, air compressors, &c. These lists are all caught together in a bright and attractive binder. Other sections of the catalogue are nearly ready.

London Shafting and Pulley Co., 62, Blackfriars Road, London.—Illustrated price list of their cast, wrought-iron and wood pulleys, shafting, couplings, &c.

Messrs. Siemens Bros.' Dynamo Works, Ltd., have again favoured us with one of their handy and very presentable pocket diaries for the New Year.

Dissolutions and Liquidations.—Hong Kong Tramway Electric Co., Ltd.—A meeting is to be held on January 18th, at 19, St. Swithin's Lane, E.C., to hear an account of the winding-up from the liquidator, Mr. G. G. Walker.

G. F. Metzger.—Messrs. G. F. Metzger and A. E. Yates, carrying on business as agents and engineers, at 17, Cooper Street, Manchester, have dissolved partnership.

The Crown Brass and Engineering Co.—Messrs. W. R. Yates and J. Watson, brass-founders and finishers and electrical engineers, River Street, Bolton, have dissolved partnership. Mr. Yates will continue the business under the old style.

Klang (Malay) Rubber Co., Ltd.—This company is winding up voluntarily, with Mr. Maurice Jenks, 6, Old Jewry, E.C., as liquidator.

Electrical Testing Laboratories, Ltd.—Creditors must send particulars of their debts, &c., to Mr. W. P. Tomes, 17, Devonshire Chambers, London, E.C., the liquidator, by January 29th.

Refuse Destructors, Ltd.—A meeting of this company is to be held at Dashwood House, E.C., on January 21st, to hear an account of the winding-up from the liquidator (Mr. F. H. Firth).

A.B.P. Accumulator Co., Ltd.—This company is winding-up voluntarily, with Mr. T. A. Pallister, of Stockton-on-Tees, as liquidator.

G. A. Steinthal, electrical engineers and contractors, Bradford, Harrogate and Newcastle-on-Tyne. — Messrs. W. P. and E. T. Steinthal have dissolved partnership. Mr. W. P. Steinthal will attend to debts, &c.

Book Notices.—*Dynamometers.* By Engineer E. N. Campazzi. Published by Messrs. Hoepli, of Milan. Price 3 lire.—This book is in pocket size, well printed, and contains 130 illustrations. The first few pages describe the conditions which must apply generally to all measurements of work and the rate at which it is done; this is followed by some general principles indicating the theory of the design of machines to carry out such measurements. The second part of the work describes the principal Continental types which have been practically developed, and certainly forms a valuable collection of useful material for reference in regard to this class of machines. The third part deals with traction dynamometers and methods of employing them, with formulæ in each case, and the author's views as to the most accurate types to employ under varying circumstances, a coefficient of correction being frequently necessary before the true average power can be determined. In the latter part of the book some practical examples of working out results are given, and tables of constants that facilitate working with some of the formulæ recommended.

"Proceedings of the American Society of Mechanical Engineers." Vol. XXVIII, No. 3. Mid-November, 1906. Baltimore, Md.: The Society, 2,427, York Road.

"Transactions of the Illuminating Engineering Society." Vol. I, No. 6. November, 1906. New York: The Society.

"The School of Mines Quarterly." Vol. XXVIII. No. 1, November, 1906. New York: Columbia University. 50 c.

"Proceedings of the American Institute of Electrical Engineers." Vol. XXV, No. 11, November, 1906. New York: The Institute. 50 c.

"Office Organisation and Management." By Lawrence R. Dicksee and H. E. Blain. London: Sir Isaac Pitman & Sons, Ltd. 5s. net.

Hart Switches.—The Hart Manufacturing Co., of 25, Victoria Street, S.W., inform us that they have supplied over 200 of their new type push-button switches for installation in the new Liverpool Cotton Exchange. This is the switch which we described a few weeks ago.

Association of Exhibitors.—At a meeting of the Council of the London Chamber of Commerce held last week, the formation of an Association of British Exhibitors was approved, and the Council authorised the Exhibitions Committee of the Chamber to consider the formation of such an association with power to confer with other bodies to add to its number and to call a meeting of those interested. At the same meeting a resolution was adopted approving of the formation of the Secret Commissions and Bribery Prevention League with the object of making known and enforcing the provisions of the Prevention of Corruption Act, 1906, in the promotion of which the Chamber has taken an active part for many years.

Telegraph Pole Tests.—Additional tests as to the breaking strain and deflection of telegraph and telephone poles, both single and double, were held at the yard of Messrs. R. Wade, Sons & Co., Ltd., in Hull, on 11th and 12th inst., supplementing those made in August last. These were carried out by Prof. Goodman, of the Leeds University, assisted by Messrs. Greener and Boyd Carpenter. The arrangements were made by Mr. Christopher Wade, and although the weather was most unfavourable, were attended by a number of persons interested in the strength of wooden poles both for power and other overhead work, including representatives of several railway companies, electric power companies and contractors. The tests were considered very satisfactory, and, in consequence, Messrs. Wade having got all the data they require, these will at once be compiled in a clear form for the use of electrical engineers and contractors.

Annual Dinner.—The annual social dinner of the firm of Messrs. Elliott Bros., electrical engineers, Century Works, Lewisham, took place at the Holborn Restaurant on Saturday, December 15th; the president, Mr. W. O. Smith, took the chair, and distributed the Athletic Club prizes during the evening. An excellent entertainment was also provided.

Saving of Waste.—The Cardiff Corporation Electric Tramways Department has placed an order with Mr. Chas. Pullan, of Bradford, for a 20-in. oil and waste-saving machine. We are informed that, after having some of its oily waste treated in one of these machines, the following results were obtained:—Out of 12 lb. of oily waste treated in one batch, 6 lb. of clean waste was obtained, and 5½ pints of oil extracted, and the following figures were guaranteed for 1 cwt. of waste reclaimed, as sample sent:—Total cost, including labour, coal and soap, 8s. 3d., less credit for 11 gals. of oil at 6d., 5s. 6d.—2s. 9d. for reclaiming 1 cwt. of waste.

Screw Prices.—Messrs. Guest, Keen & Nettlefolds, Ltd., of Birmingham, notify that on 15th inst. they reduced their discount on brass wood screws for export when sold from English lists Arts. 2 and 2A, to 62½ per cent.

Trade Announcements.—Messrs. Fraser & Chalmers, Ltd., of 3, London Wall Buildings, E.C., inform us that they have entered into arrangements with Mr. Victor H. Coates to continue the manufacture of the well-known high-class engines as made by his late firm.

The Gilbert Arc Lamp Co., Ltd., Chingford, inform us that they are making considerable extensions, putting down a high-speed Westinghouse gas engine and suction gas plant, which they anticipate will materially assist them in producing the best work more cheaply, and also will enable them more thoroughly to test and adjust all lamps sent out by them, a feature to which they attach immense importance.

LIGHTING and POWER NOTES.

Aston.—Extensions have just been completed at the Corporation power station, and on Saturday last, on the invitation of Councillor A. E. Godrich, Chairman of the Electricity Committee, several members of the T.C. and others inspected the new plant. The capacity of the new generating set is 1,000 kw., which has increased the total capacity of the station from 1,450 to 2,450 kw. The total cost of the extensions is between £15,000 and £16,000. The Chairman of the Electricity Committee started up the new machinery, and after the inspection the company adjourned to the Council House, where they dined together. In the workshops of Aston at present there are upwards of 1,000 h.p. of electric motors connected up, varying in size from ½ to 75 h.p.

Beckenham.—The Council has decided to purchase that portion of the South Metropolitan Electric Light and Power Co.'s undertaking which is in the Crystal Palace portion of Beckenham parish. The purchase price is £5,187.

Cheadle and Gatley.—The B. of T. has informed the U.D.C. that it has extended the E.L. order for a year. The Council has decided to canvass the compulsory area in order to ascertain the number of probable consumers, and to induce the Stockport T.C. to take over the order.

Darlington.—In accordance with a report submitted by the electrical engineer, the Electricity Committee has decided to erect an additional generating set at a cost of £3,700.

Dartford.—The U.D.C. has decided to supply energy for power during the night to the works of Messrs. Burroughs, Welcome and Co. at 2½d. per unit for 15,000 units, and 1½d. up to 100,000 units.

Gravesend.—Under an agreement with Northfleet U.D.C. the T.C. has decided to give notice of the Corporation's intention to supply energy to a portion of Northfleet for public lighting.

Grimsby.—The R.D.C. has agreed to consent to the application of the T.C. for a prov. order for E.L. in its district, subject to the insertion of the usual clauses safeguarding the Council's interests. The parishes to be supplied are:—Little Coates, Great Coates, Stallingborough, Harbrough, Immingham, Healing, Aylesby, Bradley, Laceby, Waltham, and Scartho.

Hampton Court.—The installation of the electric light at the Palace has now been completed, and was used for the first time at a concert on Saturday last.

Hanley.—The T.C. has applied to the L.G.B. for a loan of £5.000 for the provision of a new 500-kw. generating set, condenser, foundations and piping.

Hindley.—The Wigan T.C. has informed the U.D.C. that it is not in a position at present to supply energy in bulk. Offers from the Lancashire Electric Power Co. and the Lancashire United Tramways, Ltd., are being considered.

Hipperholme.—The U.D.C. has decided to apply for a prov. order enabling it to transfer or lease the E.L. Order, 1905, to a company.

Huntingdon.—The Electricity Works Development Co. has informed the T.C. that it does not intend applying for a prov. order for E.L., as intimated some time ago.

London.—Stepney.—In March last the E.L. Committee reported to the Council that it occasionally received applications for supplies where it deemed it advisable to ask for a deposit, but where it was not possible to obtain same; to secure such applicants as consumers it had considered the question of the advisability of adopting the use of prepayment meters. The Council, after discussion, authorised the Committee to put in prepayment meters when requested to do so, and to fix the amount of prepayment per unit to cover the cost of energy, service charges, and meter rent. Mr. A. Wright, consulting electrical engineer, and Mr. Wm. C. P. Tapper, engineer and manager, issued a joint report upon the matter on Monday. They stated that the determination of the proper basis on which to found the rate of charge had proved a matter of extreme difficulty, and had occupied a very considerable amount of time and thought. The trouble had been that owing to the fact of prepayment it is impossible to apply the maximum demand system in the same way as to ordinary consumers, while the adoption of a flat rate (having no relation to the maximum demand) of, say, 3d. or 4d., is obviously wrong in principle, although fairly simple to apply. Another difficulty was that owing to the small size of any installation which will be likely to be supplied through prepayment meters, the service cost must be kept down to the absolute minimum, otherwise the capital charges will more than absorb any profit made. The system they proposed should be adopted, combines the advantage of the maximum demand system with the simplicity of a flat rate method. Shortly, it was as follows, viz.:—It is proposed to take periods of six months ending June 30th and December 31st, and to fix a flat rate for the ensuing six months for each individual consumer, based on the average price he would have obtained if supplied on the ordinary method during the immediately preceding six months. Thus the price paid during any period will be determined by the average hours use per day during the previous period. The only difficulty here is that during the first six months in the case of a new consumer, the hours per day would have to be estimated, there being no previous six months to work upon. To get over this difficulty, it is proposed to adopt a flat rate of 4d. per unit until the completion of a six months ending June 30th or December 31st. They recommended (1) That the rate of charge for prepayment supply be a flat rate based on the maximum demand and revised at the end of each "period" of six months ending June 30th or December 31st; (2) that in determining such flat rate the average price at which any consumer would have obtained current if supplied on account at 8d. per unit for 360 hours per annum, and 1d. per unit for all further consumption shall be calculated, and the nearest whole number of pence taken as the rate of charge for such consumer for the ensuing six months. Each consumer to be dealt with individually, the maximum demand being taken as the number of 8-c.p. lamps installed, or their equivalent. In the case of new prepayment consumers, a flat rate of 4d. per unit shall be taken until a complete "period" of six months ending June 30th or December 31st has elapsed. The foregoing recommendations have been approved by the Electric Lighting Committee.

Metropolitan Area.—The following circular letter has been sent from the Comptroller of the London County Council to the various Metropolitan Borough Councils having electric lighting undertakings:—"I am directed by the Finance Committee of the L.C.C. to acquaint you, for the information of your Borough Council, that the maximum periods which will be sanctioned by the Council in future for the repayment of loans for electric lighting purposes will be as follows:—Freehold land, 60 years; buildings, 50; mains, 30; plant, 20; house connections, 12; and meters, 10 years. I am also to state that the Finance Committee consider it desirable that separate periods should be granted for the various parts of an electricity undertaking rather than one equated period representing the average of such terms." Hitherto it has been the practice of the L.C.C., as the sanctioning authority, to allow an equated period of 42 years.

L.C.C. Power Scheme.—A circular letter has been sent by the Poplar Municipal Alliance to the secretaries of the various ratepayers' associations and kindred societies within the area affected by the L.C.C. electric power scheme, with a view to advising the associations that some progress has been made, and that no delay will occur in submitting particulars of the Bill to the various organisations, and arranging concerted action to oppose the Bill.—The *Times*.

At Tuesday's meeting of the L.C.C., the Finance Committee reported having considered the recommendation referred back to it in reference to a loan of £18,985 to the Hammersmith B.C. for generating machinery, mains and meters, and house services. Having heard the views of a deputation from the Borough Council, and the advice of the engineer, the Committee again recommended the Council to sanction the loan. After discussion, the proposal was agreed to. It was also decided to approve the borrowing of £12,633 by the Islington B.C. for E.L. purposes, although the Borough Council had written that it was not prepared to take up the loan, which the County Council had offered at 4 per cent. Sanction was also given to the Marylebone B.C. to borrow £34,384 for the provision of lamps and meters, and for wiring work, and to the St. Pancras B.C. to borrow £9,831 for mains, generating plant, house services and meters.

St. Pancras.—The differences which arose out of the contract entered into by the B.C. and Messrs. C. A. Parsons & Co. for the supply of two turbo-generators have been amicably settled at a conference. The chief heads of arrangement are as follows:—(1) That as regards No. 1 set, the Council should pay the full amount due to Messrs. Parsons & Co. at once, and accept the set as completely delivered in everything except noise, Messrs. Parsons and Co. agreeing to undertake, at their own expense, to do their utmost to lessen the noise before June 30th, 1907. It is suggested that

the same measures as were taken in the case of the Lot's Road plant at Chelsea should be applied to this set. (2) That, with regard to No. 2 set, the maintenance period should be extended to June 30th, 1907, the full conditions of the contract being otherwise observed. (3) That the Council should have the full use of both sets. (4) That, with regard to payment, the contractors have been paid £9,470, of which £7,545 will be in respect of No. 1 set, leaving a balance of £1,925 paid on account of No. 2 set. The latter amount is to be made up to a sum equal to 65 per cent. of the cost of No. 2 set, leaving the balance in the hands of the Council until the final settlement. A loan of £19,440, mainly for electric lighting purposes, is to be taken up from the Prudential Assurance Co., which offers to advance the money at 3¾ per cent. This will result in a saving of £985 as compared with what would be paid to the L.C.C. if its offer to lend the amount at 4 per cent. were entertained. With regard to a sum of £22,380 required in respect of expenditure on the electricity works, £8,857 of this is to be paid out of the electricity reserve fund, inasmuch as the amount named is for turbo-generators, which were ordered as necessary to keep up an efficient supply owing to the use of one of the Browett-Lindley sets being prohibited at the King's Road station. The balance of the £22,380 is to be charged to capital account.

Fulham.—The B.C. is to take up a County Council loan of £14,000 for E.L. purposes. The actual borrowing, however, is to be deferred for the present.

Manchester.—Col. Hepper, representing the Local Government Board, held an inquiry last week at the Town Hall, with reference to the Corporation's application to borrow £60,000 for electricity purposes. The deputy town clerk, Mr. Hudson, said that in March last the city electricity undertaking had a capital of £2,267,127. During the last five years there had been a large increase in the work of the department. In 1902 the consumers numbered 4,013; in 1906, 6,339. The total lamp and motor connections equivalent in 8 c.p.—which was, in 1902, 415,115—had increased in 1906 to 847,534, and the maximum traction demand, which in 1902 was 1,210 kw., is now 8,291 kw. The units sold for all purposes were, in 1902, 10,502,299; in 1906, 40,620,514, so that, in five years, the supply had quadrupled. The revenue had increased within the same period from £134,463 to £330,370. There was paid to the sinking fund in 1902, £25,019, and to the reserve fund £7,635, making a total of £32,654; while in 1906 there was paid to the sinking fund £66,543, and to the reserve £15,219, or a total of £82 762. Many companies and large concerns in the city, Mr. Hudson said, made use of the Corporation electrical supply for power purposes. The first object of the present application was to extend and complete the plant at the Dickinson Street station and sub-station plant, at a cost of £11,094. It was desirable that further converting power should be provided in order to meet the increasing demands of the future. A second object was to provide additional generating plant at Stuart Street. The Committee were unanimously of opinion that this expenditure was necessary. The intention was to put in additional turbine units, and the gear, &c., incidental to them, at a cost of £25,250. The provision of meters would cost £7,500, and motors £16,156. A representative of the Property Owners' Association of Manchester said the application was not opposed. A similar attitude was taken by the Manchester Retail Traders' Association. The Inspector did not consider formal evidence necessary, remarking that it was pleasant to find gentlemen, who had on former occasions done the opposite, supporting the application of the Corporation. Afterwards Col. Hepper visited the electricity works.

It is significant of the growth of the city that the demand for gas continues to increase side by side with the Corporation electricity undertaking. In 12 years the number of gas consumers has doubled, and the annual increase is about 3½ per cent. The Corporation is seeking power to borrow £300,000 for gas extension purposes.

Radcliffe.—The U.D.C. has offered to supply energy for power to large works at $\frac{9}{10}$d. per unit, subject to a revision at the end of a year, and on a minimum consumption of 7,500 units per quarter.

Richmond.—In regard to the proposed Bill of the local Electric Light and Power Co., Ltd., the T.C. is to appoint an engineer to examine and report upon the works, machinery, building, and plant of the company.

Stockton-on-Tees.—The B. of T. has extended the E.L. order of the R.D.C. for a year. The Board intimates that the order will be revoked if nothing is done at the end of that period. The Council is negotiating with the Durham County Electricity Corporation for the transfer of the order.

West Ham.—The electrical engineer reported at the Corporation's meeting on Tuesday last that a local firm had six three-phase motors which were being supplied with three-phase current. It was at first a question whether the motors would have to be rewound, which would cost, including removal, about £100, or whether it would be necessary to put in special transformers. Messrs. Eustace and Gilbert took the matter in hand and found that they could adapt, with practically no alteration, the present standard single-phase transformers for giving three-phase supply. The work was commenced at six o'clock one evening when the factory was stopped, and by eight the alteration had been made and the factory was running with a supply of three-phase current. He (the electrical engineer) did not think that this had been done before with standard transformers, at any rate, on a commercial scale, but of course it had frequently been done by using specially constructed transformers. The financial saving when the Corporation came to supply the Silvertown factories (several of which had a three-phase system) would be considerable. Mr. Eustace he proposed dealing with in his next report, but he recommended that some recognition be made now to Mr. Gilbert, for what he considered a smart piece of work. It was resolved to pay an honorarium of £10 to Mr. Gilbert in recognition of his part of the work. The electrical engineer further reported that lately he had been unable to avoid fluctuations in pressure. This was due to two causes:—(1) The rapid fluctuations, occurring sometimes twice in a evening, and for a few minutes at a time, were due to the difference in the sensitiveness of the governors of the turbo-generator and the Ferranti sets. Different tension governor springs were recently put on the turbo-generator, which made a very great improvement, and Messrs. Willans were supplying some stiffer springs still, which would stop the trouble; (2) the other cause of variation in pressure was largely attributable to the fact that there were no pilot or pressure cables between the various distributing centres, and the power station. Also as the cables got loaded up as they were this winter, the variation in the time of the load between, for instance, factory, shop, and residential districts caused variation in the pressure. To remedy this he had to keep pressure recorders working at various points, and to keep continually adjusting the cable connections to equalise the load as much as possible. The boosting transformers on order would, when erected, make a very great improvement. It was only in the winter that varying pressure caused much trouble, and by next winter they could get in pilot cables, which would indicate at the power station the pressure in the different districts, and enable it to be kept quite uniform. He proposed including these pilot cables in next year's cable contract. As the 100-volt mains got overloaded, he was arranging to change sections to 200 volts, thus increasing the capacity of the cables.

Willesden.—The District Council is to offer no opposition to an application by the Metropolitan Electric Tramways, Ltd., to the B. of T. to sanction an increase of the authorised speed of 12 miles an hour on the Edgware Road line to 14 miles per hour. In August, 1904, application was made to the L.G.B. to sanction a loan of £3,000 for hire-purchase wiring, but such sanction was refused, the Board pointing out "that the effect of the proviso to Sec. 9 (1) of the Willesden U.D.C. Act, 1893, is to preclude the Council from fixing electric wiring on consumers' premises except in the cases where the Council are themselves supplying the fitting, *i.e.*, electroliers, lamps, &c., on hire." Inquiries are constantly being made with regard to the hire or hire-purchase of electrical fittings. The E.L. Committee has decided to apply to the L.G.B. for sanction to a loan of £1,000, made up as follows: Fittings, lamps and other apparatus incidental to or connected with the use of electrical energy, £350; wiring to same, £650. In order to comply with the proviso before referred to, the electric light fittings and electric wiring must be supplied and fixed through the medium of a contractor.

Wimborne.—The Bournemouth and Poole E.L. Co. has asked the U.D.C. if it would be prepared to consider the question of electric lighting should a supply be available, and the Council has replied in the affirmative.

Yarmouth.—The T.C. has decided to spend £7,000 to supplement the plant at the electricity works, by the addition of a 400-kw. steam dynamo, and for the provision of new mains. A loan has been applied for.

TRAMWAY and RAILWAY NOTES.

Aston.—More trouble is brewing in connection with the Aston tramways question. Last week, at a private meeting of the Town Council, a proposal was entertained that the British Electric Traction Co. should be released from its agreement to run the Aston Tramways, and this suggestion appears to have "got the backs up" of the three Labour members on the Council. These three members accordingly called a meeting of ratepayers, over which Mr. R. Hine presided, and in the speeches which followed, the Labour members made it clear that they would be "delighted to see the back of the B.E.T.," but insisted that the company should not be released from its obligations without the Council obtaining every penny to which it was entitled. They also insisted that a private meeting was unbusinesslike, especially in view of Alderman Evans's statement, a few months ago, that, unless the B.E.T. paid over a lump sum of £20,000 to Aston, they would not be released from their contract. In the course of some interesting figures upon this much-debated question, Councillor Parks said the construction of trams cost Aston over £230,000. The B.E.T, who came upon the scene in 1903, now came forward with a claim of £10,000 for compensation, and wanted the Council to pay £11,000 for their old trams, which the speaker designated as "almost old scrap." By a majority of 18 to 3—the latter being the three Labour members—the Council decided to empower Aldermen Smith and Evans to pay the £11,000 or a valuation of the cars, provided the company was willing to waive the claim of £10,000 for compensation. The profit made by the undertaking in 1904 was £1,900, without sinking fund and interest. In 1905 it was £7,000, and for the first six months of this year

£4,981. The interest and sinking fund on capital expenditure was about £12,500, and the cost of renewals and repairs about £5,500, so that the annual expenditure would be about £18,000, whilst so far they had only seen the possibility of a profit of £10,000. The meeting unanimously passed a resolution protesting against the Council "rushing a solution of the tramway question," and asserting that "no settlement will be satisfactory unless confirmed by a full meeting of the Council."

Belfast.—Our local correspondent states that in consequence of the numerous cases of friction between the management of the Corporation tramways and the employés, in connection with the alleged grievances of the latter, and the loss of time by the Corporation in inquiring into frivolous matters, it has been suggested that the Corporation should lease the lines to a company. Several councillors, who are disgusted with the whole affair, are in favour of this, and most likely the matter will be formally brought before the Corporation at an early date.

Birmingham.—On Saturday Sir Oliver Lodge declared that "the mind of Birmingham is occupied on the question of the Harborne trams." As a matter of fact, the mind of Birmingham has been occupied with the subject for many years, but the genial Principal of Birmingham University was more pertinently referring to the "poll" that was being taken on the question. A town's meeting had already declared in favour of the Corporation Bill for promoting an electric tramway service to Harborne, which met with keen opposition from the wealthier and more aristocratic residents. The poll, which lasted three days, was taken under the Sturges-Bourne Act, under which the number of votes recorded by individual ratepayers is governed by rateable value. The result was made known by the Lord Mayor on Monday, as follows:—For the Corporation Bill incorporating a tramway scheme, 4,972; against, 4,387—majority in favour, 585. The individual voting was much more pronouncedly in favour of the Bill, viz.:—For the Bill, 3,187; against, 1,773—majority of voters in favour of the Bill, 1,454. Harborne will, accordingly, get its trams.

The leases held by the City of Birmingham Tramways Co. do not actually fall in until 12 p.m. December 31st, but arrangements have been concluded whereby the old steam tram engines and cars will make their last journeys to-morrow (the 22nd inst.) on the Moseley and King's Heath routes, and be replaced on the next day by electric cars owned by the Corporation.

Continental Notes.—Italy.—According to the *Frankfurter Zeitung*, Italian engineers have been engaged for the past six years on the problem of improving the railway working of the Govi Tunnel, which, passing under the Ligurian Appennines, joins Genoa with the plains of Lombardy. It is contemplated to substitute electric for steam traction, with a view to increasing the serviceability of the tunnel for traffic purposes, the existing bad ventilation preventing the passage of more than a few trains daily. The scheme provides for the running of heavy trains drawn by two locomotives at a speed of 45 km. an hour, and tenders have been invited for the work. It is estimated that when electrically worked the old Govi line will be able to sustain a traffic of 1,200 goods wagons a day; for a traffic circulation beyond this amount an auxiliary line must be provided.

La Societa Impresa Elettriche Pracentine is the name of a company which has just been formed in Milan, with a capital of £40,000, to construct electric tramways in the provinces of Milan and Piacenza.

France.—It is proposed to extend the convention entered into with the Compagnie du Midi for the construction of an electric railway from Auch to Lannemezan at a cost of 15,000,000 fr. by the inclusion of a narrow gauge line from Tarbes to Castelnau-Magnoac.

Germany.—The first full gauge electric railway in Saxony is about to be constructed, the route being Limbach to Gössnitz *via* Waldenburg. It will be worked by single-phase alternating current at a pressure of 5,500 volts. A second line, but of narrow gauge, is likewise in course of construction, and will run from Hohenstein-Ernstthal to Oelsnitz *vid* Gersdorf. It will also be worked by single-phase alternating current at a pressure of 5,500 volts. The Saxon Government reserves the right to take over the former line.

Holland.—Three new lines of electric tramways have just been completed and put in operation in Rotterdam.

Exeter.—At a meeting of the Tramways Committee of the City Council on Saturday, the surveyor submitted a device, the invention of an Exonian, for the protection of the upper-deck seats of tramcars in wet weather. The idea is a very simple one, but has been worked out with no little ingenuity. It consists of a waterproof covering, which is released when the movable back is moved from the vertical position in which it usually is, and pushed to one side, as is the case with most tramcar seats. This movement causes the covering to roll up under the seat, which, according to the claims of the inventor, will have been kept perfectly dry by the waterproof covering. When the passenger rises from the seat the covering returns automatically, thus protecting the seat at all times when it is not occupied. Experiments are to be made by the Exeter Tramway Committee with a view, if successful, to the adoption by the Council of the device, which has been patented by its inventor.

London.—Great Northern, Piccadilly and Brompton Railway.—The opening of this new line to the public by Mr. Lloyd-George, President of the B. of T., took place last Saturday, 15th inst. An inaugural luncheon at the Criterion followed, at which Sir Geo. Gibb stated that the Underground Electric Railways Co. was assisting the L.C.C. with a supply of energy from the company's power station at Chelsea, for running the cars on the Embankment. Sir Edgar Speyer remarked that the Charing Cross, Euston and Hampstead Railway would be completed in June.

L.C.C.—An inspection of the new Embankment tramway was made on Friday morning last by several members of the Council. Mr. Evan Spicer, the chairman, drove the first car. The line was opened to the public on the following morning, the 15th inst. From the daily Press we learn that on the first day of opening a car left the rails at the Westminster Bridge end of the Embankment. At this point there is a curve in the track of very small radius. Other difficulties in the running also occurred at this point.

On Tuesday last the Council had under consideration the adjourned report of the Highways Committee in relation to the Vauxhall-Brixton Road tramways and proposed lines in Tooting High Street and in Mitcham Road. It was decided to sanction an expenditure of £91,870 for the construction of the lines for electric traction, and to expend £100,000 on the provision of a car-shed at Holloway. On the other hand, the Council postponed a scheme for expending £50,625 for the construction, on the overhead trolley system, of tramways from Beresford Square, Woolwich, *vid* Plumstead Road and High Street, Plumstead, to a point near the present terminus, and from Wickham Road to the county boundary at Abbey Road.

Manchester.—Should the L.G.B. sanction an application now being made by the Gorton U.D.C., for further borrowing powers, the Corporation Tramways Committee will be able to lay a double line of tramway over a portion of the new route which is to connect Stockport with Reddish, Gorton and Openshaw, and with the Cheetham Hill extension.

Middlesbrough.—The T.C. has decided to seek powers to construct a transporter bridge across the Tees.

The Channel Tunnel.—Through railway communication between England and France is a long way off, but Parliament in the next session is to be asked to consider such a scheme. It is proposed to construct two tunnels under the Straits of Dover. They will each be of a length of about 24 miles under water; and with the approaches on either side, the total length will be about 54 miles. It is proposed to haul the trains by electricity.

Torquay.—A local correspondent says the first trial trip on the Dolter system in the town has taken place. We gather that a car was experimented with over some of the roads for about an hour; it is stated to have run smoothly and attained a good rate of speed, and considering the inclement weather at the time, and allowing for minor hitches incidental to the trial of a new system the result is deemed fairly satisfactory. About an hour before the commencement of the above proceedings, a horse was killed at Torre. This, we understand, was due to a fault in one of the mains, which had been damaged during the laying of the trackwork. The owner has been fully compensated.

West Ham.—The result of the through running arrangements with the East Ham Council in Barking Road, since the extension into Barking, show that had the receipts been apportioned on the clearing-house principle, the payment to be made by either authority to the other would not have exceeded £1. The West Ham tramways manager has been authorised to endeavour to arrange for the continuance on the present financial basis of the through running agreement, an analysis to be taken out on the clearing-house system at the end of each year, and payment made for any excess of car-miles run by either authority over its proper proportion. The tramways manager has been directed to negotiate further with the East Ham Council as to the proportion of profits with regard to through running on the Plashet Lane, East Ham, section. The Leyton U.D.C. is to take energy from the West Ham Corporation at 1¼d. per car-mile run on the short length of line between Woodford Road, Forest Gate, and the Leyton system. Arrangements are being made for the working by West Ham of the section of the lines in the L.C.C. district between Coborn Road and Bow Bridge.

The T.C. has passed a resolution in favour of promoting a tramway prov. order in the next Parliamentary session to enable it to construct a tramway along Prince Regent's Lane, Custom House. The estimated cost of constructing the track and supplying the overhead equipment is £16,500.

TELEGRAPH and TELEPHONE NOTES.

Bournemouth.—The T.C., when meditating the establishment of a municipal telephone exchange, laid down a number of ducts, for which it now has no use. Negotiations are in progress with a view to leasing or selling some of them to the National Telephone Co.

Post Office Grievances.—The Select Committee which has been considering the grievances of Post Office servants has completed the taking of evidence.

(*Continued on page* 1000.)

A NEW SWEDISH ELECTRICAL COMBINE AND ITS PRODUCTS.

We recently mentioned that a combination of three large electrical firms had been formed in Sweden. The firms interested are Elektriska Aktiebolaget Magnet (the Magnet Electrical Co., Ltd.), Elektriska Aktiebolaget Holmia (Holmia Electrical Co., Ltd.) and the Clayton-Unger Electrical machine shops and foundry at Arbra.

Of these firms the Holmia Co. is the oldest, having been established in 1899. The Holmia Co. has carried on the work of contractors and engineers, having had the sole selling agency for Brown, Boveri & Co., of Baden, until 1903, when it gave up that firm to take over the agency for Clayton-Unger machinery and apparatus. The business, under the joint management of Mr. Hilding Flygt and Mr. Sven Depken, has been very successful, and the company has satisfactorily carried out work for all the principal mines and factories in Sweden, besides many municipalities and government institutions.

Fig. 1.—Works of the Magnet Electrical Co., Ludvika, Sweden.

The Magnet Co. was formed in 1900 as manufacturers of electrical plant and electrical contractors. From its inception this company has been unfortunate. The first managing director, Mr. Göransson, died before the factory was completed, and then followed a period of mismanagement, so that it has from the start worked at a loss. It has, however, fine modern shops situated at Ludvika, four hours by rail from Stockholm, and has carried out a lot of excellent work.

Fig. 1 is an exterior view of the Magnet Works, and fig. 2 a view in the erecting shop. These works are electrically-driven, and even electrically-heated power being obtained in the shape of three-phase current from an adjacent water power station.

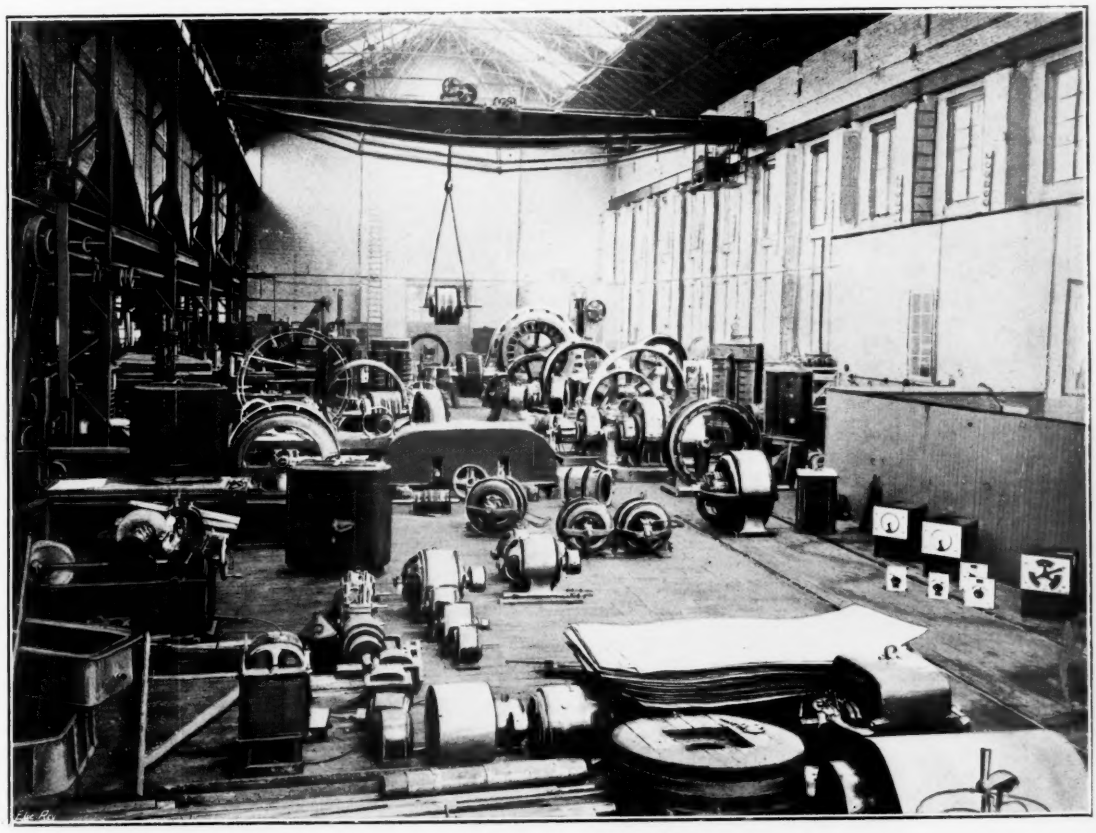


Fig. 2.—The Erecting Shop, Magnet Co.'s Works.

Fig. 3 shows a hoisting gear for the iron mines at Grängesberg, built by the Magnet Co. The winding drum has two 16-pole continuous-current motors each of 500 h.p., directly

coupled on either end, the armatures being mounted on the over hanging shaft ends. The motors run at a speed of only 20 R.P.M., and hence are the largest continuous-current machines in Sweden. These motors derive their power from two water-driven power stations, one situated 14 miles from the mines, the other 7½ miles.

The power is generated and transmitted as three-phase current, being transformed and converted for this hoisting gear to 550 volts pressure.

The total power used at the mines for pumping, hauling rock drills, locos., &c., is 4,500 H.P., and as considerable fluctuations would occur over the whole network with the continual starting and stopping of this big winder, which can take up to 2,000 H.P. at the moment of starting, the designer, Mr. Aubrey V. Clayton, adopted D.C. motors with a buffer battery to take up the peaks. The plant has now been working two years entirely satisfactorily.

Fig. 4 shows a mountain railway in the extreme north of Sweden, by the Magnet Co.

The manufacture of electrical machinery at Arbra in the mechanical engineering shops of Messrs. Ungers, formerly devoted solely to the construction of wood-working machinery, was begun by Mr. Aubrey V. Clayton in the autumn of 1903; Mr. Clayton (formerly of the British Thomson-Houston Co.) giving up his position as designer and head of the continuous current department in the Magnet Co. to carry out this work.

Incidentally, it may be mentioned that Arbra, one day's railway journey north of Stockholm, or two north of Christiania, is nearly on the same latitude as Klondyke, and is the most northerly electrical machine factory in the world.

Work was begun in quite a small way, by manufacturing continuous current and three-phase machinery and transformers of small sizes.

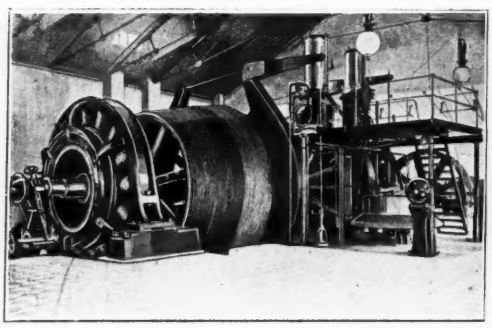


Fig. 3.—Hoisting Gear, Grängesberg, by the Magnet Co.

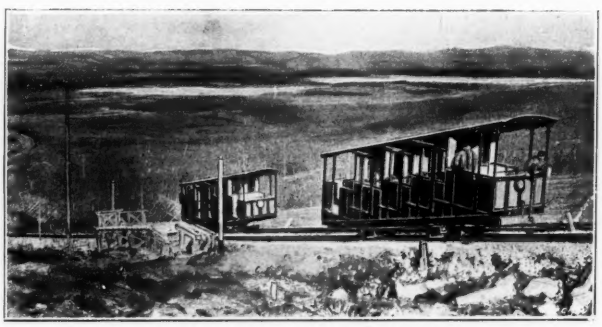


Fig. 4.—Electrical Mountain Railway at Kiruna, N. Sweden, by the Magnet Co.

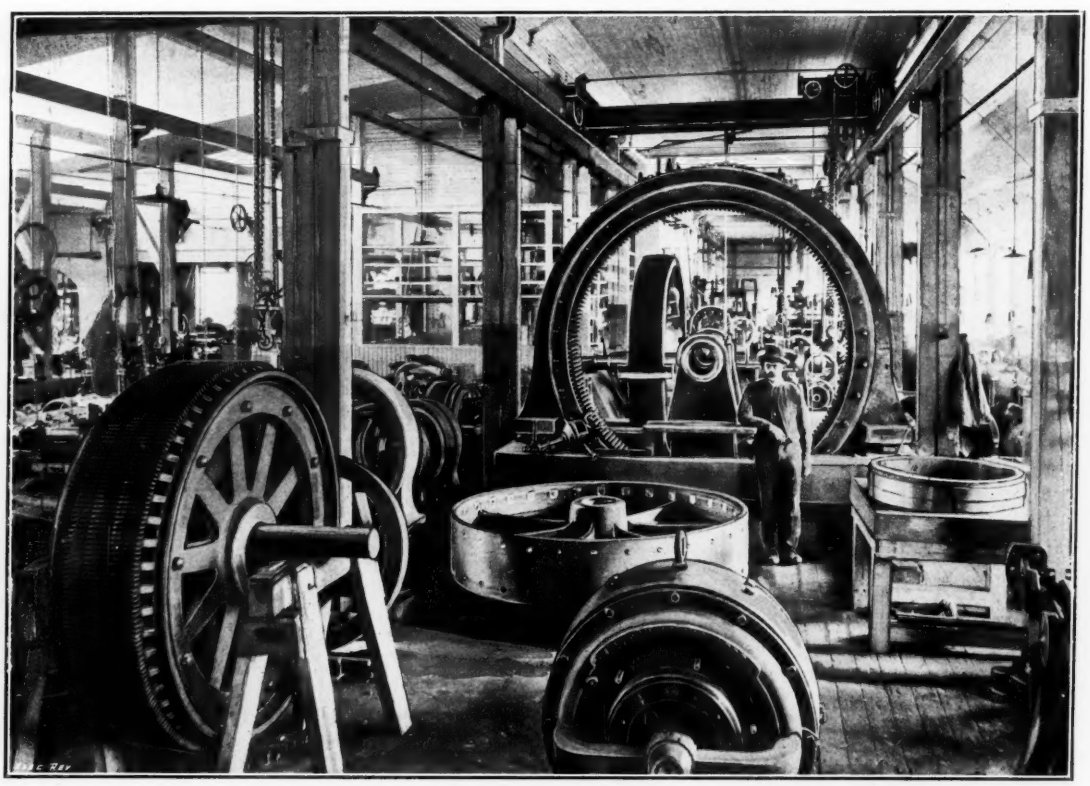


Fig. 5.—A View in the Works of the Clayton-Unger Co., Arbra.

The popularity of the Clayton-Unger plant, however, spread very rapidly, and within four months of the time of starting it was found necessary to make extensions to the works in order to cope with the incoming orders.

The output went on increasing at an extraordinarily rapid rate, new machine tools of the most modern make being continually added until the summer of 1905, when

the works were shut down, being involved in the great Swedish engineering strike and lock-out, which closed down all the principal shipyards and engineering works in Sweden for six months.

The management had, however, with considerable foresight made all necessary plans for rebuilding the greater part of the works during the enforced idleness, so that when in November, 1905, the strike and lock-out was ended, it had doubled the floor area of the works and more than doubled their capacity. With the far more commodious premises and foundry the output still further increased until, at the present time, it is three to four machines per day, which up to date this year represents over 32,800 H.P. delivered, and since the commencement of operations has reached a total of 63,500 H.P. of machines and transformers, besides a number of haulage locomotives and other plant.

It is interesting here to note that but for financial circumstances these works might have been developed in England instead of Sweden, their foundation and success being mainly due to the manager and part-owner, Mr. Clayton. It is still more interesting to note that, although electrical machinery can and is being made in Sweden and exported to England and the English Colonies at prices and of a quality which compete with the English and Continental makes, yet Mr. Clayton firmly believes that on account of cheaper material and higher output of work from the workmen, machinery can be built 10 per cent. to 20 per cent. cheaper in England than in Sweden.

Fig. 5 is a view of the interior of the Clayton-Unger works at Arbra.

Fig. 7 shows a standard three-phase 24-pole 600-H.P. 50-cycle (220 R.P.M.) induction motor, and fig. 8 a three-phase 40-pole 600-H.P. generator (150 R.P.M.), with vertical shaft directly coupled to turbine shaft, installed at the Lottefors pulping mills, both by the same firm. At present, among other interesting work in hand, may be mentioned some 3,300-H.P. generators and water-cooled transformers for a 50,000-volt transmission of 10,000 H.P.

Fig. 9 shows a three-phase 1,500-H.P. 6,000-volt generator, with a speed of 187 R.P.M., built at Arbra for a power transmission at 20,000 volts to some paper mills in Sundsvall, where it drives Clayton-Unger induction motors of 1,300 H.P.

Finally, the illustration, fig. 6, shows an exceedingly interesting machine built at Arbra. This is a single-phase rotary converter having two windings, two commutators and two pairs of slip-rings, so that it can be used on a 285 or 570-volt D.C. circuit.

This has been constructed for the works of Messrs. John Brown & Co., Ltd., Sheffield, for steel smelting by the electrical process of Mr. Otto Frick. It is an eight-polar machine with a speed of 150 R.P.M., 10 cycles, with a normal output of 260 KW. and a maximum output of 350 KW. This is probably the largest single-phase rotary yet built.

From the foregoing examples of some of the work done in the past by the three firms in partnership, it will be seen that the amalgamation is an exceedingly strong one.

All the arrangements have been confirmed by shareholders' meetings of the interested concerns, and from January, 1907, the combine will be known under the style of Förenade Elektriska Aktiebolaget, *i.e.*, the Amalgamated Electrical Companies, Ltd.

The combined companies give work to somewhat over

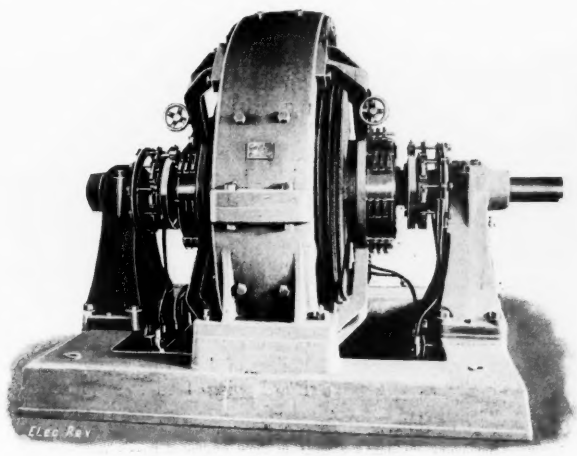


Fig. 6.—Single-phase Rotary Converter; Clayton-Unger Co.

Fig. 7.—Three-Phase 600-H.P. Induction Motor; Clayton-Unger Co.

Fig. 8.—Three-phase Vertical Shaft Generator for Turbo-drive; Clayton-Unger Co.

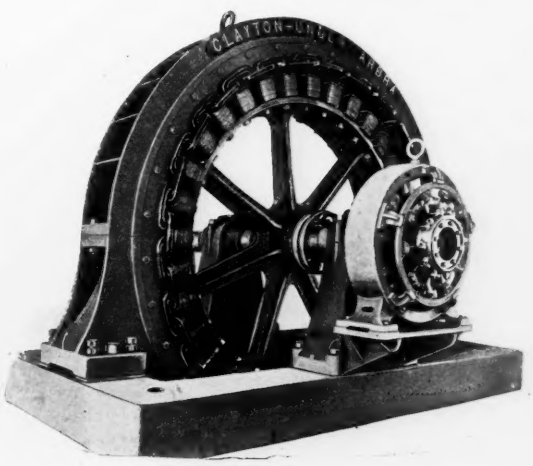


Fig. 9.—Three-phase 6,000-volt Generator of 1,500 H.P.; Clayton-Unger Co.

View on Tramway Route showing Overhead Power Cables, Street Lighting, &c., Lourenço Marques.

LOURENCO MARQUES (DELAGOA BAY) ELECTRIC LIGHTING AND TRAMWAYS.

(By our South African Correspondent.)

The concession for the electric lighting of Lourenço Marques is in the hands of the Compagnie Générale d'Electricité, and its career commenced in 1898, the contractors for which were the Cie. de Fives Lille (France).

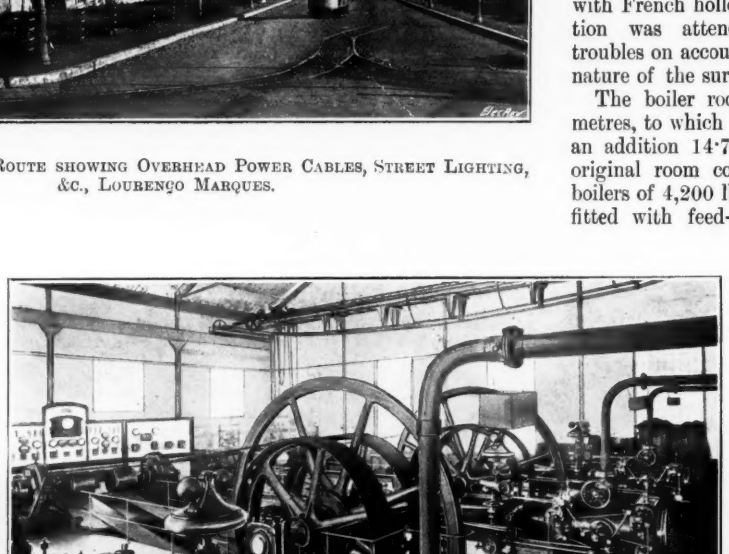
The system adopted is the three-wire D.C. with 240 volts across the outers. The station is centrally situated, and is built of iron and steel framing, lined with French hollow bricks; its construction was attended with foundation troubles on account of the then swampy nature of the surroundings.

The boiler room is 18·75 × 14·75 metres, to which has lately been added an addition 14·75 × 11 metres. The original room contains three elephant boilers of 4,200 lb. evaporative capacity, fitted with feed-water heaters, and in the extension there are two Galloway boilers of the same evaporative capacity, each 22 ft. long × 6 ft. 6 in. in dia., the fittings being of Hopkinson make. Transvaal coal is used with hand firing under natural draught, the coal consumption being 8·75 lb. per unit and steam pressure 100 lb. per sq. in. The feed pump is by Clark, Chapman, of 1,800 gallons capacity per hour, in conjunction with which is a Rankin filter. The chimney, of brick, is 100 ft. high, tapering from 1·4 to 1·1 metres. The engine room is

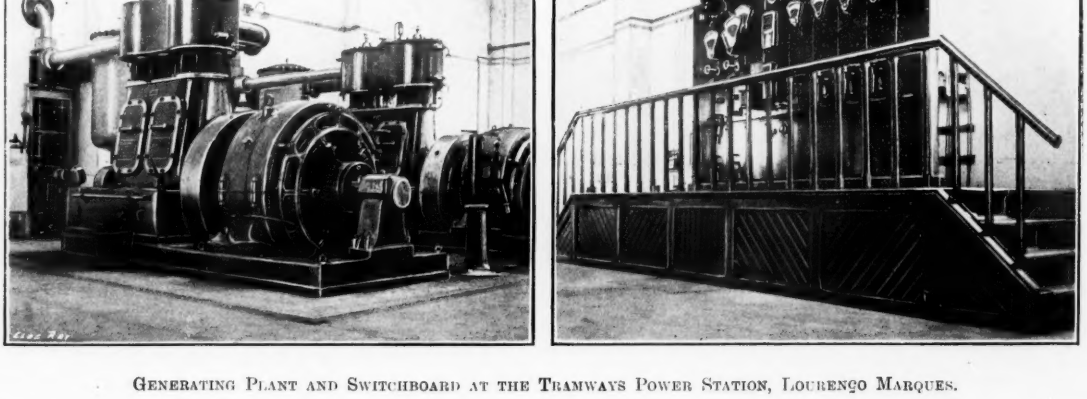
1,000 employés, and the output of the shops is about 110,000—130,000 H.P. of machinery yearly, besides switchboards, locomotives, &c.

The buildings of the combined shops, including foundries, workshops, pattern shops, offices, &c., cover an area of 15,000 sq. metres (nearly four acres), and stand on freehold properties of about 25 acres, on which also are situated workmen's dwellings, railway sidings and various yard stores.

The managing director is Mr. Hilding Flygt, and Mr. Sven Depken



The Generating Plant at the Electric Lighting Station, Lourenço Marques.



Generating Plant and Switchboard at the Tramways Power Station, Lourenço Marques.

is vice-managing director, and with Mr. Aubrey V. Clayton as chief engineer, designer and manager of the factories, a brilliant future may be expected.

18·75 × 19·6 metres, and is spanned by a 5-ton hand traveller. The engines are of the single cylinder horizontal type, by Fives Lille, and develop 130 H.P. at a speed of 72 R.P.M.,

with a stroke of 36 in., and are fitted with Corliss trip gear. The dynamos are six in number, of A.E.G. make (two being driven from each engine by separate belts) of 40 KW. capacity each.

A balancer set of 6·25 KW., by Messrs. Siemens, is being installed, capable of dealing with an out-of-balance of 50 amperes on either side, and an additional set has lately been added, with a view to a day load and to gradually replacing the belt-driven sets; it consists of a Belliss-Siemens 75-KW. D.C. set, running at 525 R.P.M.

The condensing arrangements consist of a Ledward and Beckett evaporative condenser, with motor-driven Edwards three-throw air pumps and Gwynne circulating pumps; an automatic atmospheric by-pass is also provided.

A motor-generator set has lately been added for the lighting of Reuben Point district, which is somewhat outside the limits of a D.C. supply. This plant consists of a 68-H.P. Siemens motor at 240 volts, coupled to a 45-KW. single-phase alternator, developing 2,300 volts at 750 R.P.M. and 50 cycles.

A 7/14 Helsby double-armoured and lead-covered concentric cable, 1⅛ miles in length, has been laid from the station to a transformer kiosk at Reuben Point, where a 30-KW. British Transformer Co.'s transformer supplies a three-wire network at 240 volts pressure.

The switchboard is of marble, and contains three machine panels, one meter panel, and five district panels, the districts being sub-divided into two circuits, one for public and the other for private lighting. There is also a H.T. switchboard for the motor-generator set, both boards commanding a full view of the engine room; the instruments are chiefly by Fives-Lille.

The mains supplying the various districts are carried on 25 and 30-ft. iron poles, spaced about 50 yards apart, and are of bare copper 30, 45, and 70 mils. in size, the house services being pulled off from the poles to the roofs, through Siemens line fuses. At various junctions, line-fuses are also inserted for purposes of localisation of faults. Lightning trouble is of little account, as the town is naturally protected by its position, but a few Siemens arresters are installed as a precaution.

The street lighting is a prominent feature, and certain penalties were imposed on the company when the concession was granted; the price of 3½d. per unit for street lighting and Government buildings hardly covers working expenses, and accounts for the high price charged to private consumers, which, on a sliding scale, is from 2s. 3d. to 1s. 6d. per unit, the average obtained being 1s. 9d. per unit.

There are 18 miles of streets lighted by means of 746 16-C.P. incandescent lamps, and 23 arc lamps of the Western Electric Co.'s enclosed 5-ampere type; the incandescents are spaced about 50 yards apart. The lighting hours at present are from dusk to dawn, but with the new Belliss set it is hoped that a day load of motors, fans, &c., will be forthcoming.

At present there are 278 private consumers, which, with Government buildings, total some 9,000 8-C.P. lamps, the maximum load being 156·8 KW.

The erection of the plant and all outside equipment was carried out by the Cie. Generale d'Electricité, who are the only contractors in the town for the wiring of consumer's premises and for the supply of fittings, &c., the wiring being carried out in accordance with the Phœnix Fire Office rules. The meters are mostly of the B.T.-H. type.

The engineer and manager is Mr. J. Askew, who has a staff of 10 whites and 20 natives, and we are much indebted to him for his courtesy in showing our representative around, and for his assistance in the preparation of this article.

To the enterprise of the Delagoa Bay Development Corporation, Ltd., of which Mr. Pallastrelli is the general manager, must be given the credit for the system of electric tramways, which originated from a concession granted to the Tramways Electric de Lourenco Marques. The scheme was started in 1904, the contractors being Messrs. Macartney McElroy, the system adopted being the overhead trolley, with direct current at 550 volts.

The town is well suited for the operation of tramways, being laid out in squares like most Colonial towns, and its streets are generally wide. The total population is about 5,800, and with the keen competition of the port to capture the forwarding of goods to the Transvaal, it is hoped that it will grow in importance.

The power station is centrally situated between Reuben Point, the residential quarter, and the town; the buildings are of ample proportions, being constructed of brick, adjoining the car shed, built of iron and steel, and the repair shops.

The chimney is of iron, 70 ft. high × 4 ft. 6 in. in diameter. The plant consists of two Babcock & Wilcox boilers having a heating surface of 1,426 sq. ft. each, fitted with internal superheaters, superheating to 100°, and with a steam pressure of 150 lb. per sq. in.

Induced draught is arranged for, with hand firing, but natural draught so far meets the case, with Transvaal coal, the consumption working out at 8½ lb. per unit.

There are two Clarke-Chapman feed pumps of 500 gallons capacity per hour, and a filter by the same firm in conjunction with which is a Royle's feed heater. The generating plant consists of two 200-KW. Belliss-Lancashire D. Co. sets, the engines developing 300 H.P. at a speed of 400 R.P.M. Adjoining the engines are two baffle exhaust oil separators, the exhaust being carried by a by-pass to the atmosphere, or through a Clarke-Chapman surface condenser, fitted with steam-driven air and circulating pumps by the same firm, and capable of dealing with 12,000 lb. of steam per hour. The cooling tower is of the Klein natural draught type; adjoining is an iron storage tank of 10,000 gallons capacity. The switchboard is of the B.T.-H. make, of polished slate, supported by an iron frame, on an elevated platform commanding a view of the generators. There are two machine and three feeder panels, spare machine and feeder panels, also a B. of T. panel; these are fitted with the usual instruments and circuit breakers. In addition to this there is the lighting panel for the station yard and buildings, and also for the arc and incandescent lighting of the Harbour Works, and for supplying energy for the 20, 10, and 5-ton wharf cranes, and the Temperley transporters described in our issue of June 3rd, 1904.

The machine and equalising switches are fixed on pedestals near the machines, and the engine room is spanned by a 10-ton hand traveller by Messrs. T. Smith & Son, of Leeds. The workshop is well equipped with a wheel turning and grinding lathe, hydraulic press, screw-cutting lathe, shaping and drilling machines, &c., driven by a 10-H.P. motor.

The car-shed is about 200 ft. long × 60 ft. wide, with a capacity for 25 cars, and contains five tracks, under which are the usual inspection pits. There are eight cars made by Messrs. G. F. Milnes & Co. of the single-deck four-wheel type, all of which have McGuire trucks with a 6 ft. 6 in. wheel base; also four cars by Dick, Kerr & Co. having Brill trucks, 27 E pattern, with a 6 ft. wheel base. Seating capacity is provided for 32 persons, the seats being arranged transversely generally, and the cars are mostly of the open type, and well adapted for the requirements of the climate. The lighting is by means of two groups of incandescents, arranged five in series.

The life-guards used are the Providence and Tidswell types. Each car is fitted with two motors of 25-H.P. each, eight being of the G.E. 60 type, with K 10 controllers and hand and electrostatic brakes, and four have D.K. 25 B type motors, with D.B. 1 controllers and hand and emergency brakes; the type of trolley being No. 3 Union. In addition to the passenger cars there are three freight cars, which are of great service to the municipal authorities.

Lightning arresters are fitted on all cars, as well as on the feeders at the power station, being of the M.D. type G.E.C. (U.S.A.) make.

Seven cars are in regular use, two extra cars being put on for the rush hours. The service is about 20 minutes, and the fares are based on 50 reis per kilometre. The car-miles last year amounted to 287,519, and passengers carried 721,078, the total costs per car-mile being 13d.

The track is single throughout, with the necessary turnouts; the total length is 7·76 miles, and it is laid with "girder" rails 76 lb. per yd. in 45-ft. lengths, and bonded with 0000 Crown flexible bonds. The foundation is a solid

bed of concrete 4 ft. wide; the gauge of the track is 3 ft. $3\frac{3}{8}$ in. The points and crossings are of Hadfield's manganese steel; the sharpest curve has a radius of 30 ft., while the steepest gradient is 1 in 12. Side bracket arms are mostly used, the poles being 31 ft. in length, of lap-welded steel, with a diameter tapering from 8 in. to $5\frac{7}{8}$ in.; they are set in 6 ft. of concrete. The trolley wire is of 00 size, being double practically throughout, and is supported by a double flexible suspension at a height of 21 ft. above the ground; it is fed in $\frac{1}{2}$-mile sections through the usual section boxes, of which there are eight.

There are three feeders leaving the station of 19/14 size, vulcanised rubber, which are carried overhead, supported by porcelain insulators fixed to cross-arms on the side poles. Guard wires are dispensed with, special care being taken where other wires cross the route.

In conclusion, we have to express our indebtedness to Mr. MacKenna, the engineer, for his courtesy in showing our representative round the works, and for the information which he so readily supplied.

TELEGRAPH and TELEPHONE NOTES.

(*Concluded from page* 994.)

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	**Aug. 28, 1901**	
Paramaribo-Cayenne	Nov. 27, 1906	
Cayenne-Pinheiro	**Aug. 18, 1902**	
St. Lucia-Martinique	**May 7, 1902**	
Dominica-Martinique	**May 7, 1902**	
Guadeloupe-Martinique	Aug. 29, 1906	
Mole St. Nicholas-Port au Prince	Aug. 16, 1906	
Curacao-Coro / Curacao-La Guayra / Curacao-Maracaibo	Closed.. Jan. 12, 1906	
Reissa-Issa and Reissa-Yemani (Yemen)	Oct. 22, 1902	
Tarifa-Tangier	**Jan. 18, 1904**	
Port Arthur-Chifu (Closed)	**Mar. 9, 1904**	
Garachico-Santa Cruz	July 12, 1906	
Las Palmas-Arecife	Aug. 18, 1906	
Guantanamo-Mole St. Nicholas	Nov. 22, 1906	
Mole St. Nicholas-Cap Haytien	Nov. 22, 1906	
Gibraltar-Tangier	Dec. 3, 1906	
Fao-Bushire	Dec. 4, 1906	
Odessa-Kilios	Dec. 14, 1906	
Tenedos-Salonica	Dec. 16, 1906	
Martinique-Paramaribo	Dec. 17, 1906	
Landlines.		
Puerto-Barrios	**Aug. 28, 1902**	
Via Fao, Hanekin and El Arich	Dec. 12, 1906	Dec. 17.

Telephone Agreements.—The Postmaster-General recently sued Alfred Blakesley, Putney, for £7 9s. 10d. for telephone calls and for a year's rent due in advance. Defendant said the Postmaster-General had cut him off, and he did not see why he should pay for the telephone and for future calls when he could not have the use of the instrument. Judge Lumley Smith, K.C., said that upon his construction of the agreement, judgment must be given for the Postmaster-General, with costs.

This decision, it will be noticed, is contrary to the decision in the case which we mentioned last week, and in the one which follows.

At the Newcastle-on-Tyne County Court on the 12th inst., before his Honour Judge Greenwell, the National Telephone Co. sued Messrs. G. Pearson, Shaw & Co. for £7 10s., a year's rent of the telephone. The defendants rented a telephone wire from May, 1904, and the rent in advance for the first year was paid. The rent for the second year was paid eventually. The plaintiffs were claiming up to June, 1907, and said that the six months' notice required by the agreement had not been given. The defendants said that the notice had been given by them, and that the plaintiffs themselves terminated the contract; they disconnected the telephone in July, 1905, and the defendants had not had the use of the wire since that date. Mr. Shaw said the plaintiffs claimed in November, 1905, the rent for the year that would terminate in June, 1906, and he paid that into Court under protest. He paid the last rent into Court in March this year, and he gave up the office in July this year. The telephone was not reconnected after the disconnection. The suggestion for the plaintiffs was that the telephone was reconnected after the last payment in March this year. His Honour said the plaintiffs were asking for rent for a period in which they performed no service; and judgment was given for the defendants.

At the City of London Court on Tuesday, the P.M.G. made application for a new trial of the case mentioned in our last issue. Judge Rentoul repeated that the agreement was absurd, and refused to grant him a new trial; later, however, the agreement was explained to the Judge by Mr. McIntyre, and he gave leave for the application to be renewed on a subsequent day.

Wireless Telephony.—According to Reuter, successful experiments in wireless telephony, over a distance of 25 miles, have been effected by the German Wireless Telegraph Co., in the presence of a number of guests. The experiments were conducted between the Berlin premises of the company and their station at Nauen. A correspondent of the *Standard* states that the experiments were conducted by Prof. Slaby, and were perfectly successful. The Professor seems, indeed, to have been somewhat carried away by his enthusiasm, for he is said to have stated that wireless telephony between Berlin and London would become possible in the comparatively near future, and subsequently between Europe and America. In these days we dare not say that any such development is impossible; but we strongly deprecate the utterance of such statements before there is anything like justification for them. Be it remembered that even wireless telegraphy between Great Britain and America has not yet become a practical and commercial success, though we do not doubt that messages have passed experimentally across the Atlantic.

According to the *Daily News*, Herr Poulsen six months ago succeeded in carrying on wireless telephony over a distance of 28 miles, and is now arranging for an experiment over 190 miles. He puts forward the claim that with his system tapping is impossible except by a highly skilled electrician; but who else would attempt it? Tapping is still possible.

CONTRACTS OPEN and CLOSED.

OPEN.

Australasia.—January 14th. According to *Australasian Hardware and Machinery*, tenders are being invited for telephones (9,000), magneto wall sets, for the Postmaster-General's Department, Commonwealth of Australia. Specifications, &c., at the Offices of the Deputy Postmaster-General, Sydney, Melbourne, Brisbane, Adelaide, Perth and Hobart. Tenderers to state name of country in which telephones will be made. Deposit, 5 per cent. on the amount up to £1,000, and $2\frac{1}{2}$ per cent. on any further amount in excess of £1,000. Tenders to Deputy Postmaster-General, Melbourne.

Belfast.—December 31st. 1,000-KW. steam dynamo and condensing plant for the Corporation. See "Official Notices" December 7th.

Bray.—January 1st. High-tension switchboard and instruments for the U.D.C. electricity works. See "Official Notices" November 30th.

Bridlington.—January 19th. Pumping machinery for the Corporation waterworks. See "Official Notices" November 30th.

Bury.—December 22nd. Cables for the Corporation. See "Official Notices" December 7th.

Ebbw Vale.—December 31st. Prepayment meters for the U.D.C. See "Official Notices" December 14th.

Felixstowe.—December 22nd. Switchboard for the U.D.C. See "Official Notices" December 7th.

Iceland.—March 31st. The Reykjavik Town Council is open to give a concession for the supply of electrical energy and gas. See "Official Notices" December 7th.

Islington.—December 28th. Fan 12 ft. diameter, and single-phase motor for driving the same, for the Lighting Committee. See "Official Notices" December 7th.

Kingston-upon-Thames.—December 31st. Electric wiring of new schools for the Education Committee. See "Official Notices" December 14th.

Launceston (Tasmania).—January 21st. Three-phase motors for one year. See "Official Notices" December 7th.

L.C.C.—January 22nd. Thirteen induction motor-generators of 500 KW., and four of 150 KW. capacity. See "Official Notices" to-day.

Roumania.—The municipal authorities of Campulang are about to invite tenders for the electric lighting of the town.

Salford.—January 7th. The Tramways Committee invite tenders for an installation of electric light at the receiving offices, mess rooms, &c., Central Car Depôt, Frederick Road, Pendleton. Specification, &c., on application to the General Manager, Tramways Department, 32, Blackfriars Street, Salford (one guinea deposit).

Santa Catharina.—Little is known in England of the island of Santa Catharina, although it is about as large as Barbados. Recently the authorities of the capital, Florianapolis, refused the offer of a German firm for the electric lighting of the city, and new tenders will be called.

South Shields.—December 22nd. The T.C. invites tenders for the installation of electric light in all departments of the Dean Road School. The drawings may be inspected at the office of Mr. J. H. Cawthra, M.I.E.E., Borough Electrical Engineer.

Wandsworth.—January 7th. Electric lamps for the B.C. See "Official Notices" to-day.

CLOSED.

Dover.—The Harbour Board has accepted the tender of Messrs. John Wright & Sons for electrical requisites during the ensuing year.

Hanley.—The T.C. has accepted the tender of the British Westinghouse Co., Ltd., for a 500-KW. generating set, with Howden engine, at £3,027.

London.—CAMBERWELL.—The Guardians have accepted the tender of Messrs. Wells, Rayner & Co. for Robertson lamps, at 10s. 6d. per dozen, and the tender of Reed's Electrical Co. for lamps, at 8s. per dozen.

BERMONDSEY.—The B.C. received the following tenders for the supply of 1,160 yards of 3 triple-concentric lead-covered cable:—

	Per yard.
W. T. Glover & Co. .. .. (accepted)	16s. 5d.
British Insulated & Helsby Cables, Ltd. ..	16s. 7d.
Johnson & Phillips	16s. 8d.
Callender's Cable & Construction Co. ..	16s. 8d.
Siemens Bros. & Co.	16s. 9d.
St. Helens Cable Co.	17s. 0d.

They also received the following tenders for feeder panels:—

Brush Electrical Engineering Co. .. (accepted)	£78
British Westinghouse Co.	86
Crompton & Co.	72
" "	94
British Thomson-Houston Co.	107
General Electric Co.	115
Siemens Bros. & Co.	146

The following quotations were received for a combustion recorder:—

Alexander, Wright & Co. .. .. (accepted)	£35
Sanders, Rehders	42

HACKNEY.—The B.C. has received the following tenders for additional plant:—

1,500-KW. SET AND ACCESSORIES.

C. A. Parsons & Co.	£11,023
White & Co.	13,521
Electric Construction Co.	13,863
" " .. (alternative)	14,140
Vickers, Sons & Maxim, Ltd.	14,135
" " " (alternative)	14,332
" " " (alternative)	14,343
Siemens Bros. & Co.	14,480
Crompton & Co.	14,515
Vickers, Sons & Maxim, Ltd.	14,540
Crompton & Co.	14,745
Dick, Kerr & Co. .. (provisionally accepted)	14,828
Lahmeyer Electrical Co.	14,925
General Electric Co.	15,231
British Westinghouse Co.	15,261
Siemens Bros. & Co.	15,340
British Westinghouse Co.	15,494
" " .. (alternative)	15,504
Greenwood & Batley, Ltd.	15,629
Thames Ironworks, Ltd.	16,526
Mather & Platt, Ltd.	16,921

The E.L. Committee, in its report upon the foregoing, says that the lowest tender, *i.e.*, by Messrs. C. A. Parsons & Co., was for a steam turbo-generator. This type of plant does not comply with the specification, and, moreover, it runs to such a great length, nearly 40 ft. overall, that it could not be fitted into the vacant space in the present building without obstructing the main entrance to the works. The next tender, *i.e.*, that of Messrs. White and Co., is not complete, the pipe connections and other items being omitted. Had these been included, this tender would have been one of the highest submitted, and may at once be passed over. The next tender is that of the Electric Construction Co., Ltd., of Wolverhampton, £13,863, and this is the lowest complete tender which includes reciprocating engines. They, however, offer an "interpole" dynamo, this being of a class which they have not made in a larger size than 400 KW., and as it presents a novelty which has not yet been introduced into a machine so large as 1,500 KW., the size required by the Council, the Committee did not think it prudent to take the risk of the dynamo working satisfactorily in time for the excess load which will come on next winter. The next tenderers on the list were Messrs. Vickers, Sons & Maxim, Siemens Bros. & Co., and Messrs. Crompton & Co., who desired also to have the option of supplying similar machines to the one proposed by the Electrical Construction Co., to which the same objection applies. Under these circumstances, the Committee passed on to the lowest tender which offered a dynamo of exactly similar class to that which it has at present in use. This tender was submitted by Messrs. Dick, Kerr & Co. The firm named have modern works, and have already turned out a large number of D.C. dynamos of the size required, including two dynamos of almost identical size and speed to those specified, which were supplied to the London County Council. The engine and condensing plant would both be by Messrs. Belliss & Morcom. The dynamo would be capable of taking an overload of 25 per cent. for one hour, this being rather more than is required by the specification. On the whole this tender, the Committee considered, was one of the best submitted, and it felt every assurance that the firm would be able to give punctual delivery, and in all other respects carry out the contract with entire satisfaction. It therefore had decided to accept the tender of Messrs. Dick, Kerr & Co., Ltd., subject to the usual sanction.

STOKE NEWINGTON.—The B.C. has accepted the tender of Messrs. Venner & Co. for the supply of 50 meters of assorted sizes, to be taken within a period of two years.

L.C.C.—The Highways Committee of the L.C.C. propose to accept the tender of the General Electric Co., amounting to £527, for the supply of portable blowers for use in connection with the cleaning of the machinery from time to time at the various tramway sub-stations. The offer of Mr. E. Robinson to supply a rotary sand drier and motor for the use of the tramways is also to be accepted, the price being £250.

Lowestoft.—The T.C. has accepted the tender of the Horsfall Destructor Co. for the extension of the refuse destructor, at £1,030.

Portsmouth.—The Council has accepted the tender of Messrs. Johnson & Phillips, Ltd., for electrically-driven pumps, switchboards and cables for the Southsea drainage scheme.

Radcliffe.—The U.D.C. has accepted the tender of Messrs. Etheridge & Clarke for the construction of the extension tramways.

Spain.—It is reported from Madrid that the Spanish Government have accepted the tender of the Telegraph Construction and Maintenance Co., of London, for the construction of the new cable from Barcelona to Palma (Majorca). The contract price is 775,000 pesetas.

West Ham.—The Corporation has accepted the tender of Messrs. W. H. Bowater & Co. for 7,000 tons of Newdigate coal for the electricity undertaking, at 9s. 3d. per ton, free alongside.

Yarmouth.—The T.C. has accepted the tender of Geipel and Lange for the supply of carbons, at £3 5s. 7d. per 1,000 pairs.

FORTHCOMING EVENTS.

To-day's Events (Friday, December 21st).—North-East Coast Institution of Engineers and Shipbuilders. Meeting.

At 2.30 p.m.—Civil and Mechanical Engineers' Society. Visit to the New Central Criminal Court to inspect the heating, ventilating and lighting installations.

Thursday, December 27th and Saturday, December 29th.—At 3 p.m. Royal Institution. Mr. W. Duddell on "Signalling to a Distance, from Primitive Man to Radio-telegraphy."

Human Dynamos.—Under this heading, followed by five sub-headings, the *Bradford Daily Argus* publishes a column of thrills experienced by a reporter who courageously faced the terrors of millions of volts, in the lodgings of "Dr. Macaura, a doctor who cures by electricity." The reporter asked how it was that 1,500 volts would kill, while 1,000,000 volts would cure; the doctor thought "that the voltage is too rapid and too intense to be felt by the nerves," an obviously complete and convincing explanation. The usual antics—X-rays, static discharges, high frequency currents, &c.—were performed, to the extreme edification of the reporter, who felt "quite 'toned up.'" We understand that Dr. Macaura's name appears in the American Medical Directory, which, of course, absolutely proves, to the satisfaction of reporters, that he is "really a qualified physician of America, and not one of the usual type of so-called 'electric specialists' who are now imitating him." Is not it sickening?

Train Lighting.—Although the report of Lieut.-Col. Von Donop on the Grantham disaster leaves the cause of the accident unexplained, it is interesting to note that the Inspector considers "that this accident points, as previous accidents have done, to the unsuitability of gas as an illuminant for railway vehicles." The obvious alternative is electricity.

NOTES.

Xmas Greeting.—The ELECTRICAL REVIEW heartily wishes all connected with the electrical profession and industry a Merry Christmas.

Dinners.—THE UNION ELECTRIC CO.'S HOUSE-WARMING DINNER.—On Friday last, the 14th inst., the informal opening of the Union Electric Co.'s new depôt and offices in Park Street, Southwark, was celebrated in happy style by Mr. Justus Eck, his staff, and invited guests, with a "house-warming" dinner, followed by a musical evening, at the Bridge House Hotel. The guests, who had previously inspected the Park Street premises and the many things electrical for which the Union Co. has earned a well-merited reputation, included Mr. J. E. Edgcome, President M.E.A.; Mr. Leonard Tate, Hon. Sec. Electrical Contractors' Association; Mr. Walter Davenport, Secretary, National Electrical Manufacturers' Association; Messrs. E. L. Berry, A. H. Shaw, G. Shultz, D. M. Kinghorn, H. Tomlinson Lee, and others. Toasts of "The King," "The Guests," and "The Staff," were duly honoured, and the remainder of the evening was devoted to a musical programme, which, under the direction of Mr. Fred Stevens, proved thoroughly enjoyable.

The Park Street premises, to which reference has been made, include several floors and a commodious basement, excellently adapted to the needs of the electrical business carried on by the company. The accommodation includes commercial and engineering offices and showrooms; dynamo, motor, switchgear, arc lamp, and carbon stores, &c., in which, on the occasion of our visit, examples of the company's well-known plant were on view. Among the latter, special interest attached to the oil switchgear of various types, the mechanically-ventilated motors, the numerous examples of instrument work and arc lamps—the former including various patterns of frequency indicator of the "Vibrating reed" type, and the latter, arc lamps ranging in size from the "Midget" to the well-known "Excello" patterns. In the matter of arc lighting, indeed, one may well conclude that what Queen Victoria Street has lost, Park Street has gained—the situation of the new premises being unmistakable in the evening, especially from Southwark Bridge.

THE ELECTRICAL ENGINEERS (R.E.V.) CORPS DINNER.—The annual regimental dinner of the Corps of Electrical Engineers was held on Saturday evening, December 15th, at the Criterion Restaurant, Col. R. E. B. Crompton, C.B., in the chair, and Mr. Haldane, the Secretary for War, occupying the position of chief guest, while others present included General Sir Neville Lyttleton, K.C.B.; Col. Sir Edward Ward, K.C.B.; the Hon. Rupert Guinness, representing the Naval Reserve Volunteers; Mr. Trotter, Captain C. H. Leaf, the genial surgeon of the Corps, Col. Sir George S. Clarke, G.C.M.G., Mr. Rice-Oxley, M.D., Major H. M. Leaf, Dr. Glazebrook, F.R.S., Sir A. B. W. Kennedy, and many others.

We need not detail the history of the Corps from its formation by the late Dr. John Hopkinson. The facts are already known to most of our readers. Suffice it to say, that the first annual training was held in 1898, and four camps were found sufficient, whereas during the past summer 18 camps were necessary, and attendance at camp has been absolutely necessary as a condition of efficiency. Camps are held from early in April to the end of August, and the result is that over 80 per cent. of the members are returned as efficient every year. At the close of the last annual make-up the Corps included 732 of all ranks on the establishment, the actual strength being 775.

In 1900, a detachment of eight officers, 55 N.C.O.'s and men, was sent to South Africa. This detachment returned at the end of 1900, and was found to be so useful that five companies (12 officers and 251 other ranks), under the Command of Major A. Bain, E.E.R.E. (Vol.), with Captain D. Brady, R.E., as Adjutant, were sent out. These companies formed a complete battalion, acting as an independent unit, with its headquarters at Johannesburg.

The work carried out by the Corps in South Africa consisted of everything which an engineer, electrical or otherwise, could be expected to do. Searchlights were erected and worked on block houses, forts, armoured trains and other places. Complete electric light installations were erected and worked in hospitals, railway stations and stores; detachments were employed in mechanical transport, and in erecting and lighting temporary railway bridges; and a considerable number of men were lent to the railway authorities for telegraph work. Men were employed from time to time, as required, at other work, such as erecting ice-making machinery, working and repairing locomotives and other railway stock, and general engineering work. One officer was appointed Electrical Adviser to the Commanding Royal Engineer at Cape Town.

After the customary loyal toasts, Col. Crompton proposed "The Imperial Forces," and emphasised the need for training. A half-trained man was useless, and men must be trained to fight.

In reply, Mr. Haldane laid stress on the fact that the Army cannot be effective unless it has at the back of it the spirit of the Nation. Every nation, sooner or later, throws off any system which does not fit with the national aims, and even the conscription of the Continent is borne, not because it is compulsory, but really because it accords with the ideas of the people that it is necessary. We are not wanting in national spirit, but such will be useless unless it is brought into play and made use of to support a system of national defence suitable to our needs. He was an optimist, and thought he understood his countrymen, and he felt that the army could not be a success unless inspired by the nation.

Altogether, Mr. Haldane made a speech that left the impression that he meant well. Yet at the same time it called up the weak points in our army system, namely, that each successive Secretary for War has ideas, and tries to mould the army to those ideas, and the result is that the forces which make up the army, be they regular or voluntary, are forced like hothouse plants to grow sickly growths which perish under the cold draughts of some succeeding Secretary, so that as at one time not long ago the volunteers were discouraged, at another, as at present, the regulars feel sick, and no one knows how long this or that ruling will endure. Then again, the War Office, or what passes for authority, would have, it is said, conscription on the Continental plan, and we do not believe the country would stand this. As to the cost to the country, Col. Crompton referred to the £65 per man, which regulars entailed, and compared it with the cost of the E.E. Volunteer Corps of £6 12s. 6d. as they were at present, while for an extra 30s. a very much more satisfactory condition would be attained, whereat General Lyttleton said that he thought Col. Crompton was going on to promise to supply a Chief of Staff for another 7s. 6d., and he did not doubt but that he could do it. Colonel Sir Edward Ward also spoke, and General Lyttleton presented the Hopkinson Cup, the Drill Cup and the Leaf Cup and the Testimonial to Mr. Gunn, late sergeant-major. The "Electrical Profession" was proposed by Col. Clarke, and replied to by Sir Alexander Kennedy and Dr. Glazebrook.

During the dinner a band of the Royal Engineers played a varied selection. While expressing our wishes for the success of the corps, we may well add the hope that a corps so useful and economical will not be shorn of any of its numbers in the way that seems at present to be so fashionable. If the Army is to represent the spirit of the country, then such corps as these should be supported and encouraged.

Our Own Tammany.—The following remarkable note appeared in the *Globe* of Monday last:—"Rarely, we imagine, has even the genuine Tammany Tiger of New York made an attempt at blackmail so shameless and unblushing as that with which the special organ of the London County Council is credited to-day. In a morning contemporary a circular is published which purports to come from the advertisement offices of the *London County Council Gazette*, and which, for pure audacity, surpasses the highest flights of even the defunct Works Committee. It is addressed to contractors 'who desire to offer tenders to the Stores Committee of London County Council, and who wish to keep their names before this department,' and in it their attention is gently but firmly called to the fact that 'there are four pages set aside each month in the London County Council's official gazette for their announcements.' 'The rates for spaces,' it is thoughtfully added, 'can be had on application.' We understand that the rates in question run to about £15 per annum for an eighth of a page, which, we suppose, is about the lowest bribe which any prudent contractor would think it wise to offer. The only buyer in the least likely to be influenced by such an advertisement is the London County Council itself, and the peculiar significance of the reference to contractors 'who wish to keep their names' before this all-powerful purchaser cannot be mistaken. It is childish to pretend that it is anything else but a warning that those contractors who do not undertake to pay blackmail, under the form of advertisement rates, to the tune of at least £15 a year, need not trouble to tender for County Council work. Supposing, which we have no reason to doubt, that the circular is genuine, it is impossible to conceive of a more flagrant instance of attempted corruption, and unless the Progressives promptly disavow both the circular and its author, whoever he may be, they will be under something more than grave suspicion of being the aiders and abettors of a most disgraceful attempt to extort money by means of veiled threats."

The Electrical Engineers' Ball.—Arrangements have been made for holding the fourth of these interesting and popular events at the Hotel Cecil on Friday, January 18th. There are the usual representative general and executive committees, to which additions have been made, and Messrs. A. M. Sillar and H. Alabaster are again acting as hon. secretaries, with Mr. Robert Hammond as treasurer.

Institution Notes and Lectures.—SOCIETY OF ENGINEERS.—The fifty-second annual general meeting of the Society of Engineers was held on December 10th at the offices of the Society, 17, Victoria Street, Westminster. The chair was occupied by Mr. Maurice Wilson, president. The following gentlemen were duly elected by ballot, as the council and officers for 1907, viz.:—As president, Mr. Richard St. George Moore; as vice-presidents, Messrs. J. W. Wilson, W. H. Holttum and G. A. Goodwin. As ordinary members of council, Messrs. John Aird, Joseph Bernays, F. G. Bloyd, A. G. Drury, George Green, John Kennedy, E. J. Silcock and D. A. Symons; as honorary secretary and treasurer, Mr. D. B. Butler; as honorary auditor, Mr. Samuel Wood, F.C.A.

MIDLAND INSTITUTE OF MINING, &C., ENGINEERS.—At a meeting held at Wakefield on 12th inst. Mr. P. C. Greaves, Wakefield, read a paper on "The Cost of an Electrical Unit at a Colliery."

LEEDS ASSOCIATION OF ENGINEERS.—The annual report for the year ending October 31st—the forty-first report of the Association—shows that it is in a prosperous condition. The membership roll amounts to 272; Mr. W. H. Drake is the president, and Mr. J.

Scriven vice-president, for the year 1906-7, and Mr. R. Lupton, of the Quarry Mount, Hyde Park, Leeds, is the secretary. The syllabus of proceedings for 1907 includes papers on the Leeds Tramways, by Mr. H. J. Fuller, and Producer Gas, by Mr. C. G. Norris.

Birmingham and District Electric Club.—The second annual meeting was held on the 8th inst., when officers for the ensuing year were elected as follows:—President, Mr. W. H. Whitehouse, M.I.E.E.; vice-presidents, Mr. Wm. J. Ferguson and Mr. M. G. Waggott; treasurer, Mr. E. A. Morgan; secretary, Mr. W. G. L. Riddle, City Chambers, 82, New Street, Birmingham; assistant-secretary, Mr. L. E. Oliver. It was decided to hold the meetings on the second Thursday in each month, instead of the second Saturday as hitherto.

The British Science Guild will hold its annual meeting at the Mansion House on January 28th, at 4 p.m. Mr. Haldane, the president, will speak.

On December 6th, Mr. A. Hands delivered a lecture before the Royal Engineers at Chatham on the "Protection of Buildings from Lightning."

Arc Works Engineering Society.—At Chelmsford recently Mr. Wyrill read a paper, entitled "Factory and Power Plant."

Society of Motor-Omnibus Engineers.—At a meeting held on 17th inst., a paper on "Some Commercial Aspects of the Motor-Omnibus" was read by Mr. A. A. Campbell Swinton.

Fatality.—Through the breaking of a crane-chain at the Greenwich generating station of the L.C.C. recently, a steel plate fell upon Henry Allen, aged 40, an employé of a Birmingham firm of contractors, and killed him.

Physical Society's Exhibition.—On Friday last the second annual exhibition of apparatus was held at the Royal College of Science. Our notes on this subject must be deferred until next week, for want of space.

Appointments Vacant.—Assistant works manager for Messrs. Dick, Kerr & Co., Ltd.; second resident engineer for Devon County Asylum (30s. +).

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

Central Station Engineers.—The Salford Electricity Committee has got into a difficulty on the question of the salary to be paid to the borough electrical engineer. About six years ago, Mr. C. D. Taite, of Southport, was appointed at a salary of £700, and this figure has not been exceeded, although the engineer's duties have greatly increased. The Lancashire Electric Power Co. required a manager and electrical engineer, at a salary of £1,000 per annum, and Mr. Taite being offered the post, he resigned his appointment in Salford, in order to accept it. The Electricity Committee, however, was unwilling to part with him, and a majority favoured a proposal to offer him £800 a year, with a progressive yearly increase of £50, until a salary of £1,000 was reached. This Mr. Taite would have accepted had the Committee been unanimous, but two members stood out against it. As there seemed to be no way out of the difficulty, the chairman of the Committee (Mr. Hodgson), sent in his resignation to the Mayor. The Electricity Committee, upon this, held a special meeting, and on the Mayor's suggestion, the whole matter was referred to the General Purposes Committee. On Monday last, the General Purposes Committee met privately to consider the position. Mr. Hodgson was urged to reconsider his resignation, and he promised to do so; but the ultimate issue is still uncertain.

Mr. J. H. Targett, one of the charge engineers at the generating station of the Southwark Borough Council, has resigned, having accepted another appointment.

Mr. Francis W. T. Warwick, an assistant in the meter department at the Walthamstow U.D.C.'s electricity works, has been appointed to a similar position at the Ilford U.D.C.'s electricity works.

The salary of Mr. Eustace, deputy electrical engineer of West Ham, is to be increased from £200 to £225 a year.

Mr. H. B. Sale has resigned his position as charge engineer in the electricity department of the Willesden District Council in order to take up the position of resident electrical engineer at High Barnet, Hertfordshire.

Tramway Officials.—The Oldham Tramways Committee has received 85 applications for the position of traffic superintendent of the tramways rendered vacant by the retirement of Mr. Wolstencroft. The committee selected as his successor Inspector Howark, who has been in their service since the tramways were opened.

The Manchester Tramways Committee, on Tuesday last, had under consideration the position of the general manager, Mr. McElroy, whose engagement under a five years' agreement expires at the end of the year. A resolution was passed expressing confidence in Mr. McElroy, and appreciation of his services, with a renewal of the engagement with him. The question of an increase in his salary, which had been raised, was deferred. Mr. McElroy is now in receipt of £1,000 a year.

General.—Mr. J. D. Morrison, secretary and assistant manager of the British Prometheus Co., Ltd., severs his connection with the company this week. Mr. Morrison, who has been with the company since its formation in 1902, voluntarily resigned his position on November 6th last, in order to take up a more lucrative post in the New Year.

Mr. Alfred Slatter, M.I.E.E., consulting electrical engineer, announces that he has removed his offices to 30 and 31, New Bridge Street, Ludgate Circus, London, E.C.

Mr. H. St. Hill Mawdsley, chief electrician to Messrs. Newton, Ltd., electrical engineers, of Taunton, who is leaving the town to take up a position at Dursley, Gloucestershire, was recently presented by the employés of that company with an illuminated album and a handsome clock and pair of bronze statuettes.

Mr. Lancelot W. Wild has purchased from the Electrical Testing Laboratories, Ltd., of Westminster, the plant, goodwill and all other assets connected with the carrying-on of the business of the Westminster Electrical Testing Laboratory. The business will be continued as hitherto. Associated with Mr. Lancelot Wild, Mr. Roland C. Wild, F.I.C., will continue to act as chief chemist to the laboratory, Mr. E. Richardson Blundstone, F.C.S., as consulting chemist, and Mr. Arnold G. Hansard, M.I.E.E., as consulting electrician. We understand that considerable additions are now being made to the plant with a view to extending the scope of the work undertaken at the laboratory.

Mr. T. Kerr-Jones, A.M.I.E.E., consulting electrical engineer, has removed from 49, Lime Street, E.C., to more commodious and convenient offices at 11, Victoria Street, S.W.

Mr. Henry D. Wilkinson, M.I.E.E., of 4, Queen Street Place, E.C., underwent a serious operation on Monday last week, and we are sure that his many friends will be glad to know that he is progressing favourably, and may be expected to resume his engagements towards the end of this month. During the interval Mr. Wilkinson's colleague, Mr. Frank Broadbent, M.I.E.E., is acting for him.

Sir Francis J. S. Hopwood, permanent secretary to the Board of Trade, has been appointed permanent Under-Secretary of State for the Colonies, and he is followed at the Board of Trade by Mr. Hubert Llewellyn Smith.

Mr. A. J. Peall has terminated his engagement as representative of the British Thomson-Houston Co., Ltd., 85, Cannon Street, E.C., and his present address is "Shanklin," Parkstone Avenue, Emerson Park, Hornchurch.

Obituary.—We regret to record the death of Mr. F. L. Ramsden, who, as gas engineer to the Burton Corporation, formerly acted also as manager of the electric light undertaking. The latter post he relinquished when the department was reorganised and when electric tramways were introduced in 1903.

NEW COMPANIES REGISTERED.

Electrical Installations, Ltd. (91,050).—This company was registered on December 1st, with a capital of £5,000 in £1 shares, to adopt an agreement with H. Bell, S. C. Russ and H. F. Simon for the acquisition of the business of electrical engineers and telephone specialists carried on by the said H. Bell and S. C. Russ, and the business of an electrical engineer and contractor, carried on by the said H. G. Simon, and to carry on the said businesses, and that of manufacturers of and dealers in electrical fittings, plant, lamps, stoves and utensils, &c. The first subscribers (each with one share) are:—H. Bell, 11, Queen Victoria Street, E.C., electrical engineer; S. C. Russ, 11, Queen Victoria Street, E.C., electrical engineer; H. F. Simon, 2, Mincing Lane, E.C., electrical engineer; H. Sturton, 47, Mark Lane, E.C., solicitor; R. J. Dartnall, 28, Newington Butts, S.E., gentleman; W. A. Chamberlain, Laburnam, St. Anne's Road, Barnes, S.W., gentleman; and A. J. Barnett, 46, Castlewood Road, Clapton, N.E., clerk. No initial public issue. The number of directors is not to be less than three nor more than five. The first are H. Bell, S. C. Russ and H. F. Simon, each of whom may himself act as a permanent director, or appoint another person in that capacity while he holds 200 shares; remuneration, £50 each per annum. Registered office, 11, Queen Victoria Street, E.C.

Ecco Battery and Electrical Co., Ltd. (91,032).—This company was registered on November 30th, with a capital of £2,000 in £1 shares, to adopt an agreement with Mrs. M. Andrews, and to carry on the business of electricians, electrical, mechanical, gas, water, manufacturing, consulting and general engineers, ironmongers, constructors of electric tramcars, motor-cars, carriages, cycles and other vehicles, manufacturers of and dealers in dynamos, motors, telephones, bells, batteries, lamps and electrical apparatus and fittings, &c. The first subscribers (each with one share) are:—R. D. Cooper, Rookley, Camden Park, Tunbridge Wells, director; T. Whaley, Glenartney, Clacton-on-Sea, gentleman; Mrs. J. H. Whaley, Glenartney, Clacton-on-Sea; P. Hopper, 73, Church Hill, Walthamstow, Essex, electrical engineer; H. J. Starkey, Stratheden, Grove Road, Wanstead, electrical engineer; Mrs. H. M. G. Cooper, Rookley, Camden Park, Tunbridge Wells; and Miss M. M. Rose, The Oaks, Camden Park, Tunbridge Wells. No initial public issue. The number of directors is not to be less than two or more than five; the first are R. D. Cooper, P. Hopper and T. Whaley. R. D. Cooper may retain office for five years without qualification; qualification of other directors, £100; remuneration of P. Hopper and T. Whaley, £25 per annum for each year's service; of R. D. Cooper, £50 per annum for each year's service. After such fees have been paid, the said R. D. Cooper is to receive £25 per annum for each year's service; remuneration of other directors as fixed by the company.

CITY NOTES.

India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.

The meeting of this company was held on Tuesday at the offices, 106, Cannon Street, Major Leonard Darwin in the chair.

The Chairman, in proposing the adoption of the report (see the Electrical Review, December 14th), after referring with regret to the loss the company had sustained by the death of Mr. George Henderson, one of the directors, said that the accounts were

not so entirely satisfactory as the board could wish them to be, yet there had been no hesitation in coming to the decision to recommend that the distribution to be made to the shareholders should be at the same rate as they had averaged for nearly 40 years. It would interest them to know that the total turnover of their business, taken from an average of the last five years, was within £2,000 of 10 times the total turnover taken from the average of the five years ending 1869. That meant that in a period of 37 years the business had increased tenfold. Taking another comparative period during which the business increased 300 per cent., the general expenses, excluding depreciation and debenture interest, had only increased by 60 per cent. On almost every occasion when the chairman had addressed them he had pointed out the progressive nature of the business, but he had also indicated the continual increase in competition, and latterly, the phenomenal price to which raw material had advanced. These remarks must not be understood by the shareholders to mean that the situation was one with which the board found itself unable to cope, but they merely meant that their difficulties in obtaining remunerative business were much greater, and that the management required increasing vigilance to properly understand the trend of the markets. There was a serious handicap in all industrial businesses carried on in the neighbourhood of this great city. The extravagance in municipal management due to want of knowledge of its indirect effects, injuriously influenced those businesses, and, so far as they were concerned, they believed that this extravagance was costing them some £25,000 a year more than if their works were established in the Midlands or the North of England instead of at West Ham. Fortunately, by accumulation out of the revenues of past years, they were equipped in such a way as to enable them to work at a fairly low profit, but the lowness of that profit brought with it a greater liability to fluctuation, as a small percentage on the turnover was equivalent to a large percentage on the profit. They were hoping for a lowering of the price of the materials they employed in their works; the medium classes of india-rubber still maintained their full values, but fine Para had given signs of being easier, the price that day being about 8 per cent. lower than at the corresponding period of last year. That lowering might be due to the increasing quantities of high-grade rubber which were arriving from the plantations of Ceylon and the Straits Settlements, and they anticipated that the increase would be very great in the near future on account of the large tracts of land which had been placed under cultivation in the last few years.

Mr. C. H. Moore seconded the motion, and the report was adopted.

Underground Electric Railways Co. of London, Ltd.

The directors' report to June 30th, 1906, states that the whole of the construction work of the company is now nearing completion. After the opening of the Great Northern, Piccadilly and Brompton Railway in the current month, all that will remain to be done will consist of a few months' work on the Charing Cross, Euston and Hampstead Railway.

The power-house at Chelsea and all the sub-stations for the supply of electric energy to the District Railway, the Baker Street and Waterloo Railway and the Great Northern, Piccadilly and Brompton Railway have been completed. The sub-stations and sub-station equipment for the Charing Cross, Euston and Hampstead Railway are finished, with the exception of three sub-stations, which are so well forward that they will be ready for working some time before the completion of the railway. Electric energy is now being supplied for the working of about 1½ millions of car-miles per month for the District and Baker Street and Waterloo Railways, and the directors are pleased to be able to report that the supply of current from the power-house and sub-stations has, since the commencement of electric train working, been maintained with most unfailing regularity, and to the entire satisfaction of the users of the power.

The results anticipated from the introduction of electric traction on the District Railway have not as yet come up to the expectations of the directors. These results were adversely affected by the failures and uncertainty which characterised the new train services on their first introduction; and although the train services are now working with normal regularity, the traffic has not fully recovered from the effects of the early failures.

The Baker Street and Waterloo Railway was opened for public traffic between Baker Street and Westminster Bridge Road on March 10th last. The extension to Elephant and Castle was opened on August 5th. It is expected that the line will be opened to Great Central Station in February next, and to Edgware Road in May next. The ventilation of this railway is so excellent that it has been the subject of much favourable public comment. The cars run smoothly and well, and the frequent train service, consisting of trains at intervals of 2½ minutes during the busy hours of the day, is attracting more traffic, as the facilities offered are becoming better known. There is every reason to believe that the traffic will continue to increase steadily and satisfactorily.

The railway is now ready for use except with regard to two stations, which will shortly be completed. Full train services have been running for trial for some weeks, and the complete organisation for working has been arranged and is ready for opening. Arrangements have been made for the running of a frequent train service, beginning with trains at intervals of 2½ minutes, which will be reduced to two minutes or less, if required.

The laying of the permanent way of the Charing Cross, Euston and Hampstead Railway has been completed, and the erection of all the stations is proceeding satisfactorily. The building of the rolling stock is well advanced, and so much of it has already been delivered that there is now no practical risk of any delay with regard to car equipment. The whole of the work on this railway is making good progress; it will be opened for public traffic in June next.

Since the last report the London United Tramways (1901), Ltd., authorised tramways in Kingston, Surbiton and New Malden, and between Brentford and Hanwell, which were then under construction, have been completed and put into successful operation. In connection with the Wimbledon extensions joining up with the London County Council tramways system at Summerstown and Tooting, the work is being rapidly pushed forward, and it is expected that the contractors will have completed the lines ready for opening for public traffic in May next.

Adelaide Electric Supply Co., Ltd.

The second annual general meeting of this company was held on Monday, at the offices, Finsbury Pavement House, Mr. R. P. Sellon, M.I.E.E., presiding.

The Chairman, in proposing the adoption of the report (see Electrical Review, December 14th), after apologising for the absence of Mr. J. B. Braithwaite, the chairman of the company, who is in America, said that with regard to the Adelaide undertaking the progress made during the year had been of a wholly satisfactory character. The total revenue at that station had amounted to £16,580, two-thirds of which had been obtained from lighting sources and one-third from power. They had now something like 1,000 H.P. connected to their mains at Adelaide, which compared very favourably with many undertakings covering an area of similar dimensions. They had expended £7,074 in earning that revenue, which included £1,096 expended on repairs and renewals in order to keep their buildings, plant and mains in a condition of efficiency. At Port Adelaide the revenue had amounted to £2,403, practically the whole of which had been derived from lighting, there being very little demand for power. That had cost them £2,460, including £170 on repairs and renewals, leaving a small loss of £56 on that station. At the last meeting the directors advocated, and the shareholders approved, a policy of supplying the Port Adelaide station in future from their main generating station at Adelaide, and closing down at Port Adelaide the generating portion of the plant. That policy had been given effect to during the past year, and within the next few weeks, or at most a month or two, the work would have been completed. In the meantime, however, it was satisfactory to know that the loss for the year had been reduced from the previous figure of over £300 to the present one of £56, and that loss they hoped would hereafter disappear, and Port Adelaide become a source of net revenue. There was a net profit of £9,124 on the year's working; £1,500 had already been paid in payment of a half-year's dividend on the preference shares, leaving a balance of £6,297. The directors recommended that that should be appropriated as to £2,250 in payment of the balance of dividend on the preference shares; a dividend at the rate of 2½ per, cent. per annum on the ordinary shares, £3,254; £500, being about one-third of the costs of the issue of preference shares during the year should be written off the profits; that a further £1,000 should be applied to the foundation of a depreciation account, and that the balance of £792 should be carried forward. £17,321 had been expended during the twelve months in carrying the main from Adelaide Station to Port Adelaide, and in extending their system of mains into some of the leading residential suburbs around Adelaide. On August 31st last their total lamp connections amounted to 39,396 8-C.P. lamps, and 1,119 H.P. connected to their mains, making a total equivalent of 79,204 lamps. It was interesting to note that while the increase in business during the year had been about 20 per cent, the gross profits had increased by 51 per cent. They had ordered a steam turbine plant for their Adelaide station in order to meet the growing business, and they confidently believed it would have the effect of yielding further economies in their generating costs. Negotiations had been proceeding for some time past with a view to consolidating the present system of horse tramways in Adelaide into one body, and the substitution of electric traction for horse. The Government of South Australia had introduced a Bill into the Legislature with that object in view which, he understood, had passed the Lower House. In any case that project must have an indirect bearing upon their company, and under certain circumstances it might have a very direct bearing. The shareholders might rest assured that the whole question was receiving very careful attention at the hands of the board, and they hoped the result might be such as to not only not prejudice, but to operate favourably to, the interests of the company.

Mr. A. G. Greig seconded the motion, and the report was adopted.

Subsequently, on the motion of Mr. A. F. Farish, seconded by Mr. Greig, Mr. Percy Sellon was voted £100 as additional remuneration as a director, Mr. Farish explaining that during Mr. Braithwaite's absence from the board extending over a period of seven months, Mr. Sellon had practically performed the work of two directors.

Prospectus.

The Victoria Falls Power Co., Ltd.—The prospectus, for which the public had been prepared by the very full and laudatory epistles appearing in the newspapers, has been advertised this week, offering £625,000 preference capital in £1 shares at par The list of subscriptions was to close by yesterday morning, with

the exception of applications from shareholders in the British South Africa Co., which are receivable up to 10 a.m. this (Friday) morning, and these applications will have preference in allotment up to 312,500 shares.

Since the scheme was criticised in our pages, the company's proposals have undergone great alterations. For instance, at the end of last week it was announced that Messrs. Lewis & Marks and the Vereeniging Estates, Ltd., had decided not to proceed independently with the erection of a power station at Vereeniging, as they had entered into an arrangement with the Victoria Falls Power Co., Ltd., under which Mr. Isaac Lewis joined the board of that company. When the prospectus was made public, therefore, the only rival was the Rand Central Electric Co., Ltd., which has for years been supplying power to Rand mines and other consumers. On Wednesday, 19th inst., however, after the original prospectus was well before the public, the further announcement was made that a provisional arrangement had been made with the Rand Central Electric Co. for the purchase of its undertaking, in exchange for £175,000 preference capital, and £175,000 debentures, in the Falls Co., the Rand Co. retaining its cash assets of £130,000. The Falls Co., therefore, will have the steam-driven power plant of the General Electric Power Co., at Driehook, near Germiston, on the Witwatersrand, for which it pays £150,000 in cash, it will have the exclusive right for establishing an auxiliary steam-driven station at Vereeniging, will absorb the Rand Central Electric Co., Ltd., and, lastly, may, at some time or other, proceed with its scheme for the utilisation of the Victoria Falls. The prospectus gives a good deal of information concerning contracts made with leading mining groups for power supply. The *Times*, in its financial column, received the original prospectus with the following appropriate criticism:—

"It need not be said that the enterprise, by which the greatest waterfall in the world is to be harnessed for the service of the greatest goldfield extant, is romantic and fascinating. The story of South African, and especially of Chartered, finance has shown that many shareholders seem to be content with romance and fascination, even when unaccompanied by dividends. To such as these this prospectus will appeal strongly. Those who look for profits will be comforted by the reflection that the company's steam-driven installations ought to earn it dividends, as long as it does not spend all its resources on the Falls scheme, concerning which it must be admitted that the capital cost will be a serious bar to net revenue. . . . This being so, it would not be surprising to find that, as far as the Rand is concerned, the company ultimately devoted most of its attention to steam-created power, reserving the water power of the Falls for the requirements of Rhodesia, as and when developed."

The Falls utilisation thus becomes—for the present at any rate—a small item in connection with the undertaking, and if that be so it is difficult to see what justification there is for the African Concessions, Ltd., to take one million fully-paid ordinary shares and £120,000 in cash for the various interests it has agreed to sell. Of this amount £95,000 in cash and 400,000 ordinary shares are to be provided for the British South Africa Co.; 100,000 shares go to the subscribers of the £625,000—5 per cent. debentures (if allotted); and 100,000 shares are for the acquisition of the "patent rights relating to the system of hydraulic accumulation of energy." Subscriptions for £625,000 debentures at 95 per cent. have been guaranteed conditionally on full allotment of the present issue. The British South Africa Co. will pay 5 per cent. interest per annum on the preference shares during the construction period ending December 31st, 1908. The A.E.G., of Berlin, will construct the 24,000-H.P. steam-driven plant for supplying energy "until such time as the erection of a transmission line from the Falls and the necessary works have been completed," and it is stated that it will be possible to commence delivery of power from this steam station at the end of two years.

Stock Exchange Notices.—The Committee has appointed a special settling day as under:—

Thursday, January 3rd.—Cascade (1906) Power Co., Ltd.—52,262 shares of £1 each, fully paid, Nos. 1 to 52,262; and £49,755 4 per cent. debenture stock.
Mabira Forest (Uganda) Rubber Co., Ltd.—95,000 shares of £1 each, 10s. paid, Nos. 1 to 1,002 and 26,003 to 120,000.

And ordered the undermentioned securities to be quoted in the Official List:—

City and South London Railway Co.—£150,000 5 per cent. preference stock (1903.)
Mabira Forest (Uganda) Rubber Co., Ltd.—95,000 shares of £1 each, 10s. paid, Nos. 1 to 1,002 and 26,003 to 120,000.
Montreal Water and Power Co.—£252,200 first mortgage 4 per cent. prior lien gold bonds of £100 each, Nos. 1 to 1,822 and 2,001 to 2,700 (registered).
Rangoon Electric Tramway and Supply Co., Ltd.—£150,000 4½ per cent. first mortgage debenture stock; and 30,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 30,000.

The Committee has been asked to grant a quotation to—

Ferranti, Ltd.—£100,000 5 per cent. first mortgage debenture stock.

Lancashire Power Construction Co.—This company met in London on 14th inst. Mr. Henry Wolfenden, who presided, said the accounts covered the 15 months ending December 31st, 1905. The salient feature in the accounts was that £172,540 had been raised on capital account, and £173,259 spent. The capital account was now overdrawn by £23,000. According to the report in the *Manchester Daily Guardian*, he went on to say that the shareholders were practically interested in the Power Co., which was doing active development work, the cost of which was received from the Construction Co. At the present time there was £24,000 outstanding for work done or to be done. Towards this they had available on the uncalled "B" share capital £16,644. At present, therefore, they were faced with a deficiency of capital of £31,000, which would be considered later on. The delivery of current to customers from the station at Radcliffe was begun in October, 1905, and at the date of the report there were 12 customers being supplied with energy, and others were being connected with the mains. The position was very satisfactory at this early stage, and the directors believed they were close on the time when receipts and expenditure would balance and leave a reasonable sum for depreciation and interest. The turbines and generators had been tested at the makers' works, and proved to be more efficient and to have a greater power than guaranteed by the makers. Over 50 miles of underground transmission cables had been laid, and 10 miles of overhead lines erected, together with 23½ miles of underground telephone cables and 5¼ miles of overhead telephone lines. He had been in communication with many local authorities, and in the case of Swinton and Pendlebury an agreement had been sealed for a bulk supply, but had been found to be *ultra vires*, and had been rescinded. Amongst others, one of the largest textile manufacturers in the world had given orders for 3,000 H.P. The report was adopted.

Anglo-Argentine Tramways Co., Ltd.—The debenture interest warrants for the second half of 1906 will be posted on the 29th inst., and the warrants for the preference dividend for the same period will be posted on the 31st idem.

Telephone Co. of Egypt, Ltd.—The register of transfers of 4 per cent. and 4½ per cent. debenture stock will be closed from December 18th to 31st, for the preparation of warrants for interest due January 1st, 1907.

Costa Rica Electric Light and Traction Co., Ltd.—The annual meeting of the shareholders of this company was held on Wednesday, at the offices, Dashwood House, Old Broad Street. We are unable to give a report of the proceedings, as our representative was refused admission to the meeting, and his request for a copy of the directors' report was not complied with. For the following abstract of the report we are indebted to one of our financial contemporaries:—"The report for the year ended June 30th last states that the net earnings in Costa Rica have amounted to £12,418, as against £10,159 in the previous year. After payment of debenture interest and administrative expenses, there remains a surplus profit of £2,473, as against £392 in the previous year. This has been applied in reduction of deficit from earlier years. A further issue of debentures (£10,000) was made during the year, and had been devoted to the construction of a new dam (giving greatly increased water storage) and to additional machinery and cables, with a view to meet the increased demand for current as well as to improve the service. The work is now practically finished, but no advantage whatever has been derived from it in connection with the business of the year. The new concession of 50 years both for lighting and tramway, granted to the company by the municipality on November 20th, 1905, has been confirmed by the President of the Republic of Costa Rica.

Eastern Extension, Australasia and China Telegraph Co.—An interim dividend for the quarter ended September 30th of 2s. 6d. per share, free of income-tax, has been declared.

Provincial Tramways Co., Ltd.—At the meeting held on 14th inst., the directors' report (printed in our last issue) was adopted, and the dividend recommended therein was approved.

Reduction of Capital.—In the Chancery Division of the High Court of Justice on the 11th inst. the petition of the Northallerton Electric Light and Power Co., Ltd., for sanction to a reduction of capital was considered and the order approved by the judge.

Melbourne Tramway and Omnibus Co., Ltd.—An interim dividend at the rate of 12 per cent. per annum for the half-year ending December 31st has been declared.

Blackpool Electric Tramways (South), Ltd.—The annual report states that the financial position of the company is still practically the same as last year. The 33,513 shares out of 50,000 in the preference capital of the Blackpool, St. Anne's and Lytham Tramways Co. and the 80,598 shares out of 100,000 in the ordinary capital of that company constitute virtually all the assets of the company, and, inasmuch as no dividend has been declared upon the shares of the older company, this company is still without revenue, although expenses occasioned by the continued separate existence of this company have been incurred. The directors add that they hope a scheme for terminating the separate existence of the Electric (South) Co. will be shortly brought forward again, and that the consent of all necessary parties will be obtained and the scheme completed.

Siam Electricity Co. — A Singapore paper says that the Siam Electricity Co. is to increase its capital by £30,000, to enable it to extend its operations and to redeem its 7 per cent. debentures.

France.—The balance-sheet of La Société Industrielle des Téléphones, of Paris, for the last financial year shows a profit of only £64,132, as compared with £86,956 in the preceding 12 months.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	Receipts for the fortnight. £*	No. of wks.	Total to date. £	Total to date. £*	Route miles open.	*
Aberdeen	Dec. 12	2,426	+ 12	23	41,986	+ 2,067	14·4	..
Ayr	,, 15	335	— 12	31	10,482	+ 148	8	..
Bath	,, 15	1,258	+ 32	50	40,953	+ 6,896	13	..
Belfast	,, 14	6,614	— 4	49	165,739	+48,794	40	+ 6½
Birkenhead	,, 16	1,931	— 47	37	39,614	+ 950	13·5	..
Blackburn	,, 12	1,751	+ 40	37½	39,258	+ 2,424	13·6	..
Blackpool Corp.	,, 13	593	+ 88	25	48,278	+ 3,653	11·27	..
,, —Fleetw'd	,, 15	364	+ 61	25	23,624	+ 3,814	8·25	..
† ,, —Lytham	Sep. 2	825	+ 155	39	12,897	+ 1,353	7½	..
Bolton	Dec. 16	3,822	+ 222	37	74,457	+ 6,438	26	+ 1
Bournemouth	,, 12	2,400	— 76	36½	63,322	+10,760	20·5	+ 1½
Bradford	,, 15	8,032	— 67	37	169,825	+ 6,897	53	+ ·7
Brighton	,, 16	1,371	— 101	37	38,045	..	9·5	..
Bristol	,, 14	9,087	— 127	..	..	..	28·5	..
Brit. Elec. Trac. Co.								
Airdrie	,, 7	446	..	49	10,912	+ 818	3·65	..
Barnsley	,, 7	361	— 7	,,	7,945	+ 87	..	..
Barrow	,, 7	42	+ 15	,,	12,701	+ 949	5·37	..
Cavehill	,, 7	101	+ 7	,,	4,306	+ 1,935	..	..
Devonport	,, 7	818	+ 36	,,	22,511	+ 148	8·85	..
Gateshead	,, 7	1,930	+ 98	,,	47,746	+ 2,597	11·25	..
Gravesend	,, 7	419	+ 27	,,	11,905	+ 632	6·5	..
Greenock	,, 7	1,090	— 102	,,	32,325	+ 813	7·25	..
Hartlepool	,, 7	467	— 8	,,	14,697	+ 1,664	6·72	..
Kidderminster	,, 7	177	— 3	,,	5,857	— 46	..	..
Leamington	,, 7	293	— 17	,,	8,485	+ 2,719	3	..
Merthyr	,, 7	373	+ 37	,,	9,724	+ 481	2·9	..
‡Metropolitan	,, 7	5,360	+1,412	,,	167,983	+37,964	22	..
Middleton	,, 7	576	+ 5	,,	17,183	+ 699	8·5	..
Mid. Joint Com'tee	,, 7	17,884	—1,926	,,	490,017	+11,461	..	..
Oldham — Ashton	,, 7	1,104	+ 26	,,	28,090	+ 785	9·13	..
Peterborough	,, 7	189	+ 3	,,	6,336	— 225	5·31	..
Potteries	,, 7	3,773	+ 125	,,	88,295	+ 4,430	29	..
Rothesay	,, 7	81	+ 3	,,	10,892	+ 1,612	2·75	..
Southport	,, 7	457	+ 21	,,	15,657	+ 534	8·17	..
S. Metropolitan	,, 7	1,253	..	43	15,837	..	..	..
Swansea	,, 7	1,732	+ 296	49	41,415	+ 6,027	5·5	..
Tynemouth	,, 7	304	— 43	,,	12,515	— 20	3·75	..
Weston-s-Mare	,, 5	58	+ 6	,,	7,414	+ 638	3	..
‡Worcester	,, 7	450	— 14	,,	13,919	— 783	5·75	..
Wrexham	,, 7	191	+ 3	,,	5,107	+ 190	..	..
Yorks. Wool. Dist.	,, 7	1,740	+ 79	,,	44,478	+11,828	17	..
Miscellaneous	,, 7	264	— 12	,,	5,286	— 256	..	..
Burnley	,, 15	2,243	+ 95	49	..	..	7·5	..
Burton-on-Trent	,, 16	520	+ 9	37	11,203	— 407	10	+ 1·5
Bury	,, 16	1,687	..	37	36,759	..	10·5	..
Cardiff	,, 8	3,762	+ 133	36	76,085	+ 1,354	15·87	..
Carlisle	,, 15	307	+ 10	50	9,247	+ 147	..	..
Chatham and Dist.	,, 13	1,212	+ 101	50	31,448	+ 1,855	12·8	+ 3·5
Cork	,, 13	817	— 15	50	23,920	— 40	9·89	..
Croydon	,, 14	2,452	+ 228	28	42,160	+ 4,235	12	+ ⅜
†Darlington	,, 8	196	+ 13	36	7,739	+ 295	4·67	..
Darwen	,, 14	465	+ 19	37	9,520	+ 477	4·36	..
Dover	,, 8	361	+ 9	36	9,648	+ 1,218	4·75	..
Dublin	,, 14	9,279	— 1	24	125,972	+ 6,264	18·75	+ ·25
Dundee	,, 12	2,068	+ 208	28	33,636	+ 5,964	13	+ ·5
East Ham	,, 15	1,525	+ 26	37	33,923	+ 3,173	8	+ ½
Exeter	,, 14	495	+ ·73	37	11,190	+ 400	4·75	+ ·5
Glasgow	,, 15	32,231	+1,575	31	480,977	+43,515	86·75	+11
Hastings	,, 14	1,059	..	..	..	..	..	..
Huddersfield	,, 15	2,772	+ 161	37	56,974	+ 5,203	28	..
Hull	,, 15	4,551	+ 260	37	86,220	+ 3,639	13	..
†Ilford	,, 8	468	+ 16	36	17,749	+ 481	6·37	..
Ilkeston	,, 12	233	+ 28	37	5,049	+ 618	3·5	..
Ipswich	,, 15	653	+ 5	37	16,488	+ 143	10·5	..
Isle of Thanet	,, 15	441	— 7	50	31,971	+ 934	11	..
Kilmarnock	,, 15	292	+ 13	31	4,966	+ 99	4·25	..
†Kirkcaldy	,, 12	225	+ 43	..	..	..	7·5	..
Lan'kshire Trm. Co.	,, 13	1 675	+ 68	50	44,206	+ 6,595	12·56	+ ½
Lancashire United	,, 12	2,105	+ 447	50	50·25	+ 7,137	37	+ 9
Leeds	,, 8	12 092	+ 986	34	228,747	+15,273	96	+ 6·5
Leicester	,, 15	4,054	+ 184	50	..	..	..	..
Leith	,, 8	930	+ 78	30	15,737	+ 5,713	6	+ 1
Liverpool	,, 8	21,181	+ 457	49	523,026	+12,855	104	+ 1
‡L.C.C.	,, 1	51,572	+26,496	35	921,580	+400,918	111·1	+60½
London United	,, 14	10,127	+1,369	50	308,134	+27,154	..	..
Lowestoft	,, 17	184	+ 33	11	1,925	+ 289	3·5	..
Manchester	,, 15	26 277	+1,228	18	515,897	+38,939	146	+21
Newcastle	,, 15	7,819	+ 450	37	151,444	+11,039	25·5	..
Newport	,, 15	1,115	+ 58	37	23,748	+ 1,843	14·7	+ 1·5
Northampton	,, 14	730	+ 32	37	16,578	+ 558	5·5	..
Oldham	,, 16	3,814	+ 213	38	69,259	+ 6,804	13·75	..
Pontypridd	,, 15	293	+ 23	37	6,214	+ 258	3·5	..
Portsmouth	,, 15	2,389	+ 24	37	76,625	+ 971	14·5	..
Preston	,, 12	1,344	+ 190	..	..	..	10	..
Reading	,, 13	1,120	+ 23	37	23,800	+ 457	7·5	..
Rochdale	,, 15	1,672	+ 158	36	..	..	20·6	..
Rotherham	,, 13	669	+ 110	37	18,720	+ 1,822	10	+ ·66
Salford	,, 10	8,447	+ 205	36	164,910	+ 6,438	38·9	..
Sheffield	,, 15	10,533	+ 835	38	202,279	+14,945	45·75	+ 1½
Southampton	,, 12	1,658	— 47	36½	36,433	+ 568	..	..
Southend-on-Sea	,, 12	490	+ 37	37	15,753	+ 1,036	6	..
Sunderland	,, 16	2,459	+ 64	37	52,783	+ 3,130	10·87	..
†Swindon	Nov. 28	153	— 8	33	6,300	..	4·4	..
† Tyneside	Dec. 12	387	+ 40	50	22,631	+ 2,187	8·87	..
†Walthamstow	,, 15	381	+ 63	37	24,324	..	9	..
West Ham	,, 13	4,160	+ 490	37	84,268	+18,559	14·7	+ 1·4
Wolverhampton	,, 12	1,594	+ 102	36	31,639	+ 1,699	12·5	..
Yorks. W. Riding	,, 16	1,863	+ 368	50	43,190	..	..	..
Baker St.-Waterloo	,, 15	4,305	..	24	39,215	..	3·75	..
Cen. London Rly.	,, 15	13,845	— 821	24	145,876	— 6,963	6	..
City & S. Lon. Rly.	,, 16	6,302	— 263	24	64,913	+ 1,533	6·25	..
Dublin-Lucan Rly.	,, 14	183	..	24	2,989	..	7	..
G.N. and City Rly.	,, 15	3,966	+ 180	24	41,328	+ 2,524	8·5	..
L'pool Overh'd Rly.	,, 16	2,659	— 52	24	35,401	— 423	6·8	..
Mersey Railway	,, 15	3,616	+ 156	24	40,981	+ 2,945	4·5	..
Metropolitan Rly.	,, 14	32,139	..	24	359,566	..	70·5	..
Met. District Rly.	,, 13	16,469	+ 891	24	185.618	+13,417	24	..
Anglo-Argentine	,, 16	35,199	+5,071	50	765,894	+90,598	48	..
§Auckland	,, 7	10,325	+ 430	49	119,887	+ 7,817	19·24	+ ·6
§Brisbane	Nov.	11,836	+1,068	..	..	..	..	..
§Brit. Columbia Rly.	Oct.	25,542	+3,541	17	93,472	+12 248	..	..
Bu'n's A'r's E.T.Co.	Nov. 17	3,185	+ 379	46	63,897	+ 9,414	24	..
Bu'n's A'r's-Bgr'no	Dec. 9	8,110	+1,135	49	179,532	+ 9,804	..	..
Calcutta	,, 15	6,867	+ 764	..	..	..	..	..
§Cape Electric T. Ld.	Nov.	14,396	..	..	..	..	..	..
§Geneva	,,	7 213	+ 221	..	..	..	..	..
§Kalgoorlie, W.A.	,,	3,728	..	48	46,661	..	30·5	..
Madras	Dec. 15	1,001	+ 105	50	22,044	+ 2,650	10·5	+1½
§Lisbon	Nov.	25,682	..	..	..	..	..	..
§Mexico	Sep.	74,400	..	..	..	..	..	..
Perth (W.A.)	Dec. 14	3,467	+ 891	50	72,961	+ 8,999	24·25	+5

* Compared with the corresponding period of 1905. † One week only.
‡ Includes horse, steam and other receipts. § One month

STOCKS AND SHARES.

Tuesday Afternoon.

If we had any intention of throwing a strenuous energy into this column the week before Christmas, the very prices in their markets would fight against us. For alterations are like the plums in charity puddings for sparseness, and items of news as cedar trees on the sand for multitude.

There are not many, however, who have heard of a new electric lighting company which may possibly put in an appearance after the holidays, the capital being required for a well-known holiday resort in Cornwall. So far, matters are rather embryonic, and only a few of the preliminary details have been settled.

Criticism of the new Victoria Falls power scheme has not been noted for its severity except in one or two places of honourable exception. Whether or not the lavish method of advertisement adopted may be responsible for the silence of some of the popular guides in finance, we need not now inquire. A dealer in the Stock Exchange summed up one aspect with a certain amount of neatness. "Will it go, do you think?" he was asked. "Why people should give any premium in the market," he replied, "when they are pretty certain to get every share they want at par by applying, for the life of me I can't see." The price quoted in the Stock Exchange was $\frac{1}{16}$ to $\frac{1}{8}$ premium—the usual "extra turn" added to the other attractions of the programme as unfolded in the prospectus. But the Stock Exchange has taken only a languid interest in the concern.

Last Saturday's opening of the latest Tube was accomplished without let or accident, but the price of the shares has not benefited by the attention called to them. It is not at all unlikely that the new company will do more good to allied undertakings at first than to its own proprietors, but the route is an excellent one, and in time the bulkily-named Great Northern, Piccadilly and Brompton may do well. One always remembers, however, that the Central London, with its splendid route, comfortable and quick service, has hitherto paid no more than 4 per cent. on the Ordinary capital, and that there is some doubt whether even this modest rate will be distributed in respect of the year now closing.

Metropolitan Ordinary eased off two points to 61½, upon the idea that the newcomer will capture most of the traffic between Hammersmith and the North of London. This it is almost sure to do, since it offers a service more expeditious, convenient and economical. It may happen, however, that the amount of lost traffic will not turn out to be a particularly heavy one, after all.

Districts are 20, and the other electrical issues are unchanged on the week.

Telegraph varieties are slow to make any recovery. Eastern Extensions rose ½ to 13¾, but Eastern Ordinary remains dullish at about 133, while the Preference stock has receded another point. The American Companies' issues are lower, and West India and Panama at $\frac{9}{16}$ have lost $\frac{3}{16}$. This diminutive fraction was gained by West Coast of America shares. Marconi's are down to $\frac{7}{8}$, a further small fall.

In the telephone list, the 4 per cent. Debenture stock of the National Company rose 1, and this is the solitary fluctuation.

Weakness, as usual, is the key-note of the electricity supply group. Falls have taken place in Charing Cross Ordinary and City undertaking Preference. Metropolitan Ordinary at 7½ are the ½ lower. Two or three debenture stocks have each shed a point, but Urban Debenture hardened and so did Central Electric Debenture. The former is the stock we were indicating a few weeks back as a reasonably cheap 4½ per cent. investment.

London United Tramways Debenture is 2 lower; business was marked on Monday at 90½. This, notwithstanding that the stock is full of dividend, and that the company is one of the group working with the various Tube lines that owe their inspiration, and some of their energy, to the Underground Electric Railways Company of London. British Columbia Preference is a little lower, and Brisbanes rallied to 1⅝.

Manufacturing shares show a hardening tendency. British Aluminium have again advanced, this time to 6 middle. Brush Ordinary hardened to 35s., and Electric Constructions to 7s. There was a slight decline in Dick, Kerr Ordinary shares. More interest is being taken by the general public in the Industrial market as a whole, and the other day there was a buyer, at 25s., of Willans and Robinson Ordinary shares. Trade in electrical circles, however, is not brilliant, and, rather than labour the unpleasant point, the risk is taken of this column looking unduly short to editorial eyes when any offer to prolong it with jeremiads would only arouse the readers' noes.

Anglo-Portuguese Telephone Co., Ltd.—The directors have declared an interim dividend at the rate of 3 per cent. per annum.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last four years. 1903.	1903.	1904.	1905.	Closing Quotations Dec. 11th.	Closing Quotations Dec. 18th.	Business done week ended Dec. 18th, 1906. Highest	Lowest.	Rise + or Fall —
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3 — 3½	3 — 3½	..	..	..
155,600	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	84 — 93	88 — 93	..	..	..
702,600	Anglo-American Telegraph	Stock	60/6	61s.	2½%	3½%	66½ — 68½	66 — 68	66	..	— ½
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5½%	6 %	109 —110	108 —109	108½	108	..
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	1½%	26⅝ — 26⅞	26 — 26½	26 1/16	26½	— ⅜
50,000	Anglo-Portuguese Tel., 6% Mort. Deb. Stock Red.	100	..	..	..	..	102 —104	102 —104	..	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	8 %	6⅞ — 7⅛	6⅞ — 7⅛	6 15/16	..	..
1,992,856	Commercial Cable Stlng. 500 year 4 % Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	97 — 99	97 — 99	98	..	..
16,000	Cuba Telegraph	10	6½%	10 %	5 %	5 %	8½ — 9	8½ — 9	..	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %	17 — 18	17 — 18	..	..	..
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %	8⅜ — 8⅝	8⅜ — 8⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 %	9 — 9½	9 — 9¼	..	..	..
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	100 —103	0 —103	..	..	..
60,710	Direct United States Cable	20	3½%	3 %	3½%	4½%	15½ — 16	15½ — 15⅝	15⅝	15¼	— ½
55,500	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200,£.	100	4½%	4½%	4½%	4½%	101 —103	101 —103	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	7 %	132 —135	132 —137	135	130½	+1
2,000,000	Do. 8½ % Pref. Stock	100	8½%	8½%	8½%	8½%	89 — 91	88 — 90	89½	..	—1
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 %	105 —107	105½—107½	..	..	+ ½
800,000	Eastern Extension, Australasia, and China Tele.	Stock	7 %	7 %	7 %	7 %	123⅝ — 124	123⅝ — 124	124	123¾	+ ⅜
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	105½—107½	105½—107½	107	..	..
800,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 8,000, red. 1909	100	4 %	4 %	4 %	4 %	99 —101	99 —101	..	..	..
800,000	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	4 %	99 —101	99 —101	..	..	..
180,887	Globe Telegraph and Trust	10	£3	5½%	5½%	5½%	10 — 10½	10 — 10⅝	10⅜	10	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14 — 14½	14 — 14½	14½	14	..
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	24%	35½ — 35½	35½ — 37½	36¼	36	+1⅛
37,900	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,900, Red.	100	4½%	4½%	4½%	4½%	100½—102½	100½—102½	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	13 %	58 — 60	58 — 60	..	..	..
251,127	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	Nil	7/16 — 1	7/16 — 15/16	..	..	— 1/16
72,680	Monte Video Telephone Co., Ltd. Ord.	1	8 %	8 %	4 %	5 %	1 — 1⅛	1 — 1⅛	..	..	..
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	5 %	7/8 — 1	7/8 — 1	..	..	..
1,933,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	107½—109½	107 —109	108½	107	— ½
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %	106½—108½	105 —107	108	106½	—1½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	..	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	10 — 12	10 — 12	..	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5¼ — 5½	5⅛ — 5⅜	..	..	..
2,000,000	Do. do. 5½ % Deb. Stock Red. ..	Stock	5½%	5½%	5½%	5½%	96 — 98	96 — 98	97½	95	..
1,689,598	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	100½—102½	101½—103½	103	102½	+1
179,318	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6¾%	6¾%	7½%	1½—1⅝	1½ — 1⅝	26/10½	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1⅜ — 1½	1⅜ — 1½	..	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	97 — 99	97 — 99	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
11,839	Reuter's	8	5 %	5 %	5 %	5 %	7¼ — 7⅜	7¼ — 7⅜	..	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½%	101 —104	101 —104	..	..	..
3,201	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	126 —129	126 —129	..	..	..
70,000	United River Plate Telephone	5	7 %	8 %	8 %	8 %	6⅛ — 7⅛	6⅛ — 7⅛	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5¼ — 5⅝	5¼ — 5⅝	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	110 —113	110 —113	..	..	..
15,509	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	10 — 10⅛	10 — 10⅛	..	..	..
80,008	W. Coast of America, 1 to 80,000 & 58,001 to 58,008	2½	Nil	Nil	Nil	Nil	3/16 — 1/4	3/16 — 1/4	..	..	+ 1/16
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	4 %	4 %	4 %	4 %	100½—102½	100½—103½	..	..	..
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980 ..	10	7 %	7 %	7 %	7 %	13½ — 14	13½ — 14	13¾	13½	..
558,880	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	101 —104	101 —104	..	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	3/16 — 1/4	1/4 — 3/8	10/-	..	— 1/16
34,553	Do. do. 6 % Cum. 1st Pref.	10	7 %*	7 %*	6 %	5 %	7½ — 7⅝	7½ — 7⅝	7⅝	..	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	Nil	5⅜ — 6⅜	5⅜ — 6⅜	..	..	..
80,000	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	101—104	101 —104	..	..	..

Including arrears.

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

270,000	Anglo-Argentine Trams, Nos. 260,008 to 510,007, and 560,008 to 580,007	5	..	..	8 %	8 %	7 7/16— 7 7/8	7 7/16— 7 11/16	7 7/8	7 7/8	..
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5 9/16— 5 11/16	5 9/16— 5 11/16	5 11/16	5 11/16	..
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	139 —142	139 —142	..	..	..
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	104 —106	104 —106	..	..	..
800,000	Babcock & Wilcox, 1 to 800,000	1	..	17 %	20 %	20 %	3⅞ — 4⅛	3⅞ — 4⅛	81/3	80/-	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1 3/16 — 1 5/16	1 3/16 — 1 5/16	..	..	..
88,000	British Aluminium, Ord., 2,001 to 40,000	5	..	..	7 %	7 %	5 13/16 — 6 1/16	5⅞ — 6⅛	6 1/16	6 1/16	+ 1/16
40,000	Do. do. 7 % Cum. Pref...	5	Nil	Nil	7 %	7 %	6½ — 6⅝	6½ — 6⅝	6 9/16	6⅝	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	6 %	6 %	5¾ — 5⅞	5¾ — 5⅞	..	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	4 %	4 %	4 — 4¼	4 — 4¼	..	..	..
258,000	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	101 —105	101 —105	..	..	..
800,000	Do. do. 5½ % Loch Leven Debs. ..	100	..	..	..	..	100 —103	100 —103	..	..	..
800,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	6 %	127 —132	127 —132	..	..	..
800,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	5 %	108 —112	108 —112	111½	108	..
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	108 —111	107 —110	109¼	109	—1
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½%	4½%	4½%	102 —105	102 —105	..	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	103 —106	102 —105	102½	..	—1
188,801	British Electric Traction	10	3 %	3 %	3 %	3 %	4¼ — 4⅜	4¼ — 4⅜	..	..	..
161,487	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %	8¼ — 8⅜	8¼ — 8⅜	8¼	8 5/16	..
1,415,422	Do. do. 5 % Perp. Deb. Stock	Stock	5 %	5 %	5 %	5 %	107 —110	107 —110	..	..	..
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	85 — 88	85 — 88	86¼	..	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %	6⅜ — 6⅞	6¼ — 7	6⅞	6⅞	+ ⅛
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	5⅝ — 6⅛	5⅝ — 6⅛	..	..	..
600,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	102 —105	102 —105	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	94 — 98	94 — 98	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1½ — 1⅝	1½ — 2	..	..	+ ½
1,016,858	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	73 — 77	73 — 77	..	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	9/16 — 11/16	9/16 — 11/16	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref. ..	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	2½%	2 — 1	2 — 1	..	..	..
150,000	Do. Non-cum. 6 % Pref. ..	2	6 %	6 %	6 %	6 %	1¼ — 1⅜	1¼ — 1⅜	33/1½	..	+ ⅛
125,000	Do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	4½%	95 — 97	95 — 97	..	..	..
125,000	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 — 85	82 — 85	..	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	8 %	4 %	8 %	3 — 3⅛	3 — 3⅛	64/4½	..	..
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	6 %	5¼ — 5⅝	5¼ — 5⅝	..	..	..
27,500	Do "B" do. 1 to 27,500	5	..	6 %	6 %	6 %	4⅜ — 5¼	4⅜ — 5¼	100/-	99/4½	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	105 —107	105 —107	105½	105½	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	102 —105	..	..	..
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	8 %	7⅞ — 8⅜	7⅞ — 8⅜	7⅞	..	..
22,610	Do. 105,001 to 127,610	5	..	..	..	8 %	7⅞ — 8¼	7⅞ — 8¼	..	..	..
29,390	Do. 5 % Cum. Pref., Nos. 1 to 29,390	..	..	..	..	..	5¼ — 5⅝	5¼ — 5⅝	5⅜	5 1/16	..
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 —106	..	..	..
85,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	15%	9¼ — 10¼	9¼ — 10¼	..	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝ — 5⅞	5⅝ — 5⅞ xd	5¼	..	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	103¾—110¾	103¾—110¾	..	..	..
491,222	Cape E. Trams., 1 to 491,222	1	15 %	10 %	6 %	Nil	1/16 — 1/8	1/16 — 1/8	10/3	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	£	..	..	..	6 %	1 1/16 — 1 1/8	1 1/32 — 1 1/32 xd	28/1½	..	..
220,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4 %	4 %	6 %	97 —102	97 —102	100½	100	..
1,799,696	Central London Railway, Ord. Stock	Stock	4 %	4½%	4½%	4½%	83 — 85	83 — 85	84½	83½	..
690,816	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	4 %	98 —100	98 —100	..	..	..
690,816	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	72 — 75	72 — 75	72	..	..
1,680,000	City and South London Railway	Stock	5½%	5½%	5½%	4½%	41 — 43	41 — 43	42½	42	..
85,000	Crompton & Co., Nos. 1 to 85,000	£	5 %	5½%	5½%	5½%	1½ — 1⅝	1½ — 1⅝	..	..	..
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	94 — 97	94 — 97	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—(Continued)

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—(continued).

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years.				Closing Quotations Dec. 11th.	Closing Quotations Dec. 18th.	Business done week ended Dec. 18th, 1906.		Rise + or Fall—
		†	1902.	1903.	1904.	1905.			Highest.	Lowest.	
260,000	Dick, Kerr & Co., 1 to 260,000	1	..	..	10 %	10 %	1 7/16 — 1 1/8	1 3/8 — 1 1/8	..	..	— 1/16
305,000	Do. do. 5 % Cum. Pref., 1 to 305,000	1	..	6 %	6 %	6 %	1 1/8 — 1 1/4	1 1/8 — 1 1/4	..	..	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 —106	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5½%	6 %	6 %	14 — 15	14 — 15	..	..	..
59,987	Do. 6% Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14 — 15	14 — 15	..	..	..
99,261	Edison & Swan Utd., "A" shrs., £8 pd., 1 to 99,261	5	Nil	Nil	2½%	4½%	1½ — 1⅔	1½ — 1⅔	32/3	..	..
17,189	Do. "A" shares, 01—017,189	5	Nil	Nil	2½%	4½%	2⅓ — 2½	2⅓ — 2½	..	..	..
344,023§	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	86 — 88	86 — 88	..	..	..
100,000§	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	90 — 95	90 — 95	..	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	Nil	1/16 — 1/8	1/8 — 7/16	..	..	+ 1/16
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	7 %	7 %	7 %	7 %	1½ — 2	1½ — 2	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	83 — 86	83 — 86	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	5 %	9 — 9½	9 — 9½	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	94 — 97	94 — 97	..	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %	3½ — 3⅔	3½ — 3⅔	..	..	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10⅓ — 10⅔	10⅓ — 10⅔	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	102 —103	102 —103	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	15%	11 — 12	11 — 12	11 7/16	11	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	4½%	5 5/16 — 5 7/16	5 5/16 — 5 7/16	..	..	..
150,000	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	106 —108 xd	106 —108	107½	106	..
60,000	India-Rubber, Gutta-Percha & Telegraph Works..	10	10 %	10%	5 %	10%	17 — 18	17 — 18	17 7/16	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1⅞%	1½%	Nil	1⅜ — 1⅝	1⅜ — 1⅝	..	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	6 — 7	6 — 7	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	3 %	8½ — 9	8½ — 9	..	..	..
899,980	Do. do. 60,008 to 100,000 (£6 paid)	10	..	8 %	6 %	3 %	3½ — 4½	3½ — 4½	..	..	..
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	8 — 9	8 — 9	..	..	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	90 — 95	88 — 93	90½	..	—2
814,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	3 %	1/16 — 1/8	1/16 — 1/8	..	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	29/32 — 31/32	29/32 — 31/32	..	..	..
850,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½%	4½%	97 —100	97 —100	..	..	..
150,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 50,000	5	..	..	6 %	6 %	4 5/16—4 13/16	4 5/16 — 4 13/16	..	..	..
24,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	4 %	6 — 7	6 — 7	..	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	7½ — 8½	7½ — 8½	7½	..	..
245,000	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	98½ —101½	98½ —101½	..	..	..
37,850	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	15 %	30 — 32	30 — 32	..	..	..
150,000§	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	89 — 91	89 — 91	..	..	..
640,000	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	3½%	100 —103	100 —103	101	..	..
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	3⅓%	3 %	Nil	Nil	1 — 1⅛	1 — 1⅛	..	..	..
66,666	Do. 6 % C. P., 30,001 to 80,000 & 125,001 to 141,666	5	..	6 %	Nil	Nil	2⅛ — 3	2⅛ — 3	..	..	..
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	73 — 78 xd	73 — 78	..	..	..

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5⅓%	4 ⅝%	5 — 5½	5 — 5½	..	..	..
60,000	Do. do. 4½ % 1st. deb. stock	100	..	4½%	4½%	4½%	99 —101	99 —101	..	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 29,377	5	8 %	10 %	10 %	10 %	8½ — 8⅔	8 — 9	..	..	..
10,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	7⅞ — 8	7⅞ — 8	..	..	..
800,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	100 —103	101 —104	..	..	+1
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %	3½ — 4½	3⅞ — 4½	..	..	— ½
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	4⅛ — 4⅜	4⅛ — 4⅜	90/-	..	..
80,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	3⅞ — 4½	3⅞ — 4½	..	..	— ½
420,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —104	100 —103 xd	..	..	..
44,436	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	6 %	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	..	..
175,000§	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	106 —109	106 —109	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	6 %	9½ — 10½	9½ — 10½	10½	10	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	11 — 12	11 — 12	11½	..	..
400,000§	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	123 —126	123 —126	125⅝	..	..
800,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	100 —103	100 —103	101	..	..
40,000	County of Durham Electrical Power, Ord.	2	4 %	4 %	£3 7 0	4 %	2⅛ — 3⅛	2⅛ — 3⅛	..	..	..
60,000	Do. do. do. 5 % Pref.	5	5 %	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	5 %	7⅛ — 8⅛	7⅛ — 8⅛	7⅞	..	..
80,000	Do. do. 6 % Pref., 40,001—80,000	10	6 %	6 %	6 %	6 %	10½ — 11⅛	10½ — 11⅛	11	10⅞	..
400,000§	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	107 —110	107 —110	107⅛	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	99 —102	98 —101	99½	..	—1
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	4 %	2⅜ — 3⅛	2⅜ — 3⅛	61/3	58/9	..
80,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	4⅜ — 5⅛	4⅜ — 5⅛	5	98/9	..
320,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	99 —102	99 —102	..	..	..
10,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	5½%	5½ — 5⅝	5½ — 5⅝	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	4⅞ — 5⅛	4⅞ — 5⅛	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	99 —102	99 —102	..	..	..
13,000	Hove, 1 to 13,000	5	..	8½%	8½%	9 %	7⅞ — 8⅛	7⅞ — 8⅛	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½	12 %	10 %	9⅛ — 10⅛	9⅛ — 10⅛	..	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3	4 %	1⅜ — 2⅛	1⅜ — 2⅛	42/6	..	..
60,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	6 %	4⅜ — 5⅛	4⅜ — 5⅛	..	..	..
874,295	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	96 — 99	95 — 98 xd	97½	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8½%	10 %	10 %	7½ — 8⅛	7 — 8	7⅞	7½	— ½
76,121	Do. 4½ % Cum. Pref. 1—71,106, £8 pd.	5	4½%	4½%	4½%	4½%	5⅜ — 5⅝	5⅜ — 5⅝	..	..	..
220,000§	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	109 —113	108 —112	..	..	—1
250,000§	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	98 —101	98 —101	..	..	..
75,000	Newcastle-on-Tyne, 1 to 75,000	5	..	8 %	8 %	8 %	7⅞ — 8	7⅞ — 8	..	..	..
75,000	Do. 5 % Pref., 1 to 75,000	5	..	5%	5 %	5 %	5⅝ — 6⅛	5⅝ — 6⅛	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	7½%	13½ — 14½	13½ — 14½	..	..	..
64,000	Do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	97 —100	97 —100	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	7 %	6 — 6½	6⅛ — 6½	6	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	98 —100	98 —100	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	12½%	9⅛ — 10⅛	9⅛ — 10⅛	10	9 15/16	..
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %	7 — 8	7 — 8	..	..	..
150,000§	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	4 %	1½ — 2⅛	1½ — 2⅛	..	..	..
60,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	73 — 77	73 — 77	..	..	..
65,000	South London Electricity Supply, Ord.	5	12½	8 %	4 %	4 %	2⅜ — 3⅛	2⅜ — 3⅛	59/4½	58/1½	..
120,000	South Met. Elec. Lt. & Power, Ord.	1	Nil	Nil	Nil	2½%	1 3/16 — 1 5/16	1 3/16 — 1 5/16	..	..	..
117,968	Do. Do. 7 % Pref.	1	Nil	7 %	7 %	7 %	1⅛ — 1⅜	1⅛ — 1⅜	24/4½	..	..
200,000	Do. Do. 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	102 —105	102 —105	..	..	..
50,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	3⅜ — 3⅝	3⅜ — 3⅝	..	..	..
80,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	4 — 4½	4 — 4½	80/-	..	..
230,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	4½%	98 —101	99 —102	100⅜	..	+1
110,000	Westminster Electric Supply, Ord.	5	12 %	18½%	14 %	13 %	9 — 10	9 — 10	9⅜	9¼	..
25,151	Do do. 4½ % Cum. Pref. (Originally 5%—Red. to 4½ % from 31st Dec., 1905.	5	5 %	5 %	5 %	5 %	5¼ — 5⅜	5⅛ — 5⅜	5⅜	5 7/16	..

Shares not officially quoted:—Mackay Companies, ord., 73—75. Pref. 70—72.

† Unless otherwise stated all shares are fully paid. § Interim dividends.

Bank rate of discount 6 per cent. October 19th, 1906.

THE ADAPTABILITY OF ELECTRICITY IN FOGGY WEATHER ON RAILWAYS.

By J. H. R.

"The future has no fear for electric light, electric power or electric traction. It is better than gas for all three purposes. From the point of view of price, health and domestic hygiene there is nothing to compare with electric light." Thus spoke the President of the Local Government Board at Brighton, and the trend of events justifies that opinion.

The utilisation of electricity in the various details of railway management is a marked feature of the present day. On

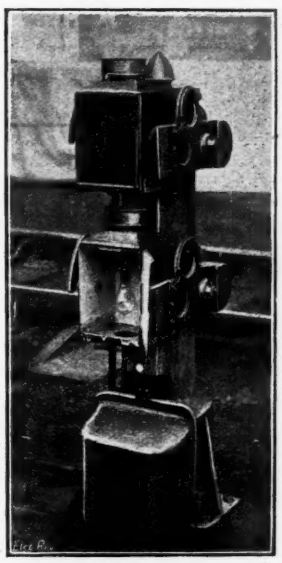


Fig. 1.—Electric Signal Lantern. (L. & Y. Ry., Bolton.)

every enterprising line electric appliances are being designed, or existing ones improved upon, in order to secure better control over traffic, greater expedition in loading and unloading mineral trains, and last, but by no means least in the order of importance, more effectually to safeguard the travelling public from accident. Railway passengers can have little or no idea what precautions are taken in the directions named, neither can they be expected to realise what an indispensable factor electricity is in coping with the holiday traffic of midsummer or the congested train service of dark December.

It may not be generally known that thousands of signal lanterns are illuminated by electricity (fig. 1) notwithstanding the warnings that were gratuitously tendered a few years ago against what at that time was considered "a very risky innovation." Experience has shown that electric glow lamps if properly installed will never become extinguished through a gale of wind; moreover, signalmen are provided with switches whereby all the lamps under their respective control may be lighted at any hour of the day or night, and this arrangement has proved of such value in snowstorms and in foggy weather that the conversion from gas to electricity has given unqualified satisfaction.

So far as the question appertains to signalling, it must be admitted that electricity as a motive power is far preferable to the "manual" system, though the latter still survives because of its lower initial cost. Suppose a heavy downfall of snow occurred during the night, and while the storm was at its height the ringing of an electric "block" bell gave warning of an oncoming train. More than likely the roads would require resetting. If the lever frame were connected on the "all-electric" or electro-pneumatic principle, as illustrated in fig. 2, a suitable movement of the point lever would cause a current to flow along the underground wire, and thus actuate the motor governing the fouling bar and facing point movements. Providing both the latter reverse in proper sequence, a *return* current is transmitted to the lever frame, energising an electro-magnet, liberating a lever latch and satisfying the signalman beyond doubt that the bar and points have responded to the lever motion. Failing this return indication, every conflicting lever is safely locked at danger until someone has been dispatched to localise the fault, which in this case will be traceable to an accumulation of snow between the points—then, and not until then, may the train be allowed to proceed. Without adducing other reasons, a greater measure of confidence is experienced in stress of weather when points and signals are controlled by electrical energy.

The prevalence of fog during the present month provokes the inquiry as to whether the fog problem is insoluble. Certain authorities affirm that the thick, yellow, health-destroying fogs are traceable to causes which may be removed, whereas the white fogs are perfectly natural, and we shall always have them, since they are the result simply of condensation. From a railway standpoint either kind is objectionable, and the attention of our readers is specially directed to a class of instruments known as electric fogging apparatus which require no greater current to operate them than that obtainable from a Leclanché cell, or from the modest "track" battery having a potential difference between its terminals of 1·079 volts. Curiously enough, it has been thought that these appliances announce a change of weather, like the warnings given by a barometer. As will be seen from the accompanying diagrams and explanatory remarks, such is not the case. Generally speaking, the function of a railway fog indicator is (*a*) to warn a fogman whether certain signals are on or off, or (*b*) to apprise a signalman when a train is standing at his home signal. Occasionally the system includes (*c*) an insulated track circuit which automatically controls a rear signal while the advance section is blocked, a subject whereof due notice will be taken. As regards the case (*a*) of a fogman having electrical facilities for ascertaining whether the signals he is concerned with are on or off, it may be explained that on the approach of dense gloom a fogman, whose ordinary vocation may be that of a platelayer or goods porter, proceeds to the station-master or pointsman for instructions without necessarily waiting to be called upon.

Fig. 2.—Modern Electro-Pneumatic Signal Lever Frame. (Bolton.)

After being supplied with the usual complement of flags, hand lamp and detonators, he commences duty at a stated locality. Suppose that on his arrival the signal-arm were lowered—indicative of a clear road for an approaching train

—a suitable hand signal would be exhibited to assure the engine driver; but if, on the other hand, the signal stood at danger, the specified number of detonators, according to the rules of the different companies, would be placed upon the line of rails for which he was fog-signalling and a red light displayed from the bull's-eye lantern. After this fashion is the cycle of operations continued while the fog lasts. As a rule a fogman can observe the movements of a semaphore from his shelter close by, but it is a well-known fact that in a Scotch mist or a London fog it is most difficult to see any object more than a yard ahead. Somewhat similar conditions prevail in the great industrial towns of the North, and the question naturally arises: How is a fogman to know the position of a signal arm 30 ft. above his head? A reply, off-hand, cannot be given, as circumstances alter cases. The information could be obtained from an examination of the counter-balance weight near the foot of the signal, though latterly it has become the practice to bolt the balance lever casting high up the post in order to reduce the length of rodding to a minimum. This would, of course, accentuate the difficulty; then again, the presence of slot weights, controlled from adjacent signal boxes, would confuse the fogman; such a practice is crude, and could not be officially recognised. A far more practical solution is to be found in the adoption of miniature ground disks which repeat the movements of the larger arms above. The only objection that can be urged against these fog-signalling devices is that of contraction of the steel wire in cold weather, fresh adjustment being required at the worst period. It may be partly on this account that electric repeaters are being substituted at the busiest parts of the line. Fixed upon the site of the recovered mechanical one, the electrical instrument is suitably protected in a combination battery box which has a glass door front to facilitate inspection; the wiring sketch descriptive of the connections is given in fig. 3. Two indications only are arranged for, viz.: The needle points to "off" when metallic contact is made at the springs behind the signal arm, current being supplied from one or two Leclanché cells. Immediately the circuit is broken the repeater needle is restored to "on" by gravitation. An intermediate, or "wrong adjust" position so noticeable in signal-box apparatus is quite unnecessary at a fog hut, since a doubtful signal is always treated as a danger signal, and the metal springs are so regulated that electrical continuity is not established until the signal arm is dipping at an angle between 45° and 55°. A small cut-out switch is employed to disconnect the instrument and to save battery power when not in actual use. Our illustration shows a double-armed bracket post joined up in the manner described; if only one signal were involved, the wiring would be precisely the same, minus one set of contacts.

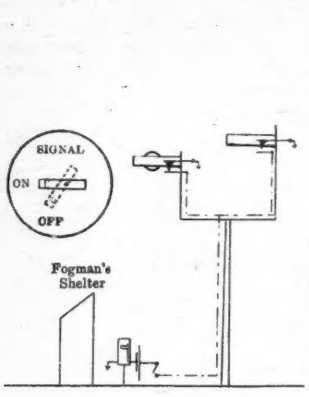


Fig. 3.—Dial of Electrical Repeater, and Diagram of Connections.

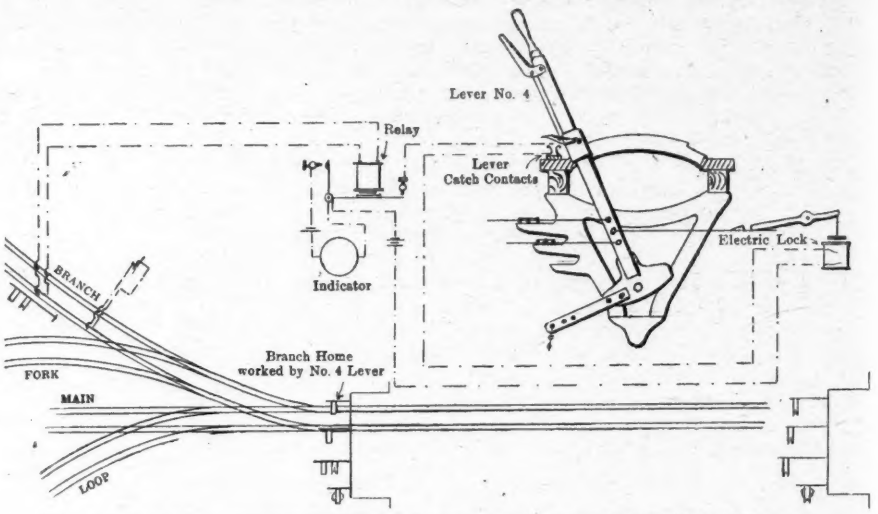


Fig. 6.—Electrical Control of Signal Lever from Insulated Rail-Track Circuit.

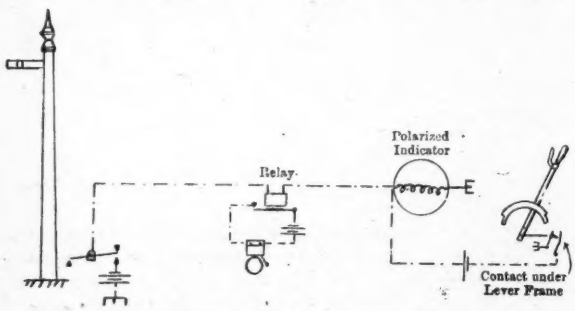


Fig. 4.—Electrical Warning Arrangement Between Home Signal and Pointsman's Cabin.

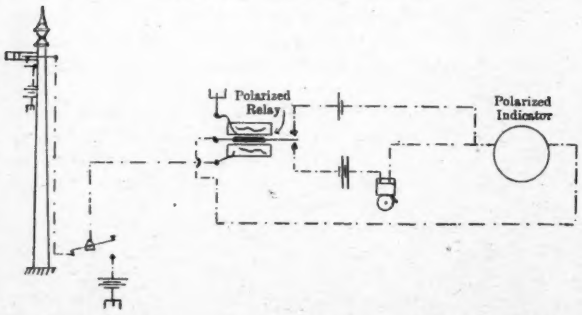


Fig. 5.—Alternative Method of Reversing Indicator Directly from the Signal Arm.

Consider (*b*) the means adopted of notifying a signalman when a train is standing at his home signal. The fact that such a provision should be necessary in addition to the block telegraph, the telephone and other electrical auxiliaries intended to aid a signalman in the discharge of his duty, is not undeserving of comment. Under normal conditions the approach of a train can be plainly seen, and the moment of its arrival correctly timed: not so in a fog; what with the explosion of detonators and the screaming of engine whistles amidst a pall of gloom, the situation is one that demands unceasing vigilance from the railway staff, and not a little forbearance from the railway passenger. If an engine were brought to a stand outside an important junction, owing to the signal standing at "danger," the fireman would descend from the footplate and depress a ringing key near the stop signal (the fogman could perform this task if instructed) which would momentarily ring a bell and drop the red flag of a polarised indicator in the signal box (fig. 4). Thus, however busy a signalman may be with other work, the sight of the block needle reminds him that a train is traversing the section, and immediately the indicator flag drops an additional warning is supplied that the train in question is standing at his home signal. As soon as the path is clear, the signal is lowered and the train proceeds on its way. The act of pulling over the manual lever closes a contact under the cabin frame, and a reverse current passing through

the indicator coils restores the flag to its original position without ringing the bell. The reliability of this arrangement is based upon the assumption that a signal-arm always responds to the lever movement. On rare occasions a home signal wire operated manually has been known to break without the signalman being the first to discover the fact. If through any cause the arm failed to move with the lever, the flag would be reversed while the train continued at the signal. Such a contingency is to be avoided if possible. It is undoubtedly safer to replace the flag directly from the signal arm, and fig. 5 is submitted as an alternative scheme. These appliances are serviceable, not merely in foggy weather, but if at any time a train were unduly delayed at a home signal without apparent reason, a timely ring from the fireman would prove a useful reminder to the pointsman. Furthermore, they are not recommended for wayside stations, but wherever a multiplicity of trains converge upon a large terminus or junction, their adoption is fully justified.

In our third and final description of an electrical arrangement designed with the object of (*c*) locking a signal in the rear while the advance section is blocked, it should be stated that this case differs from the foregoing in that its sphere of usefulness extends the whole year round. Nevertheless, it is deserving of extended reference on account of its value in foggy weather.

The essential parts of the system are: The gravity battery, insulated rail circuit, track relay, line $\left\{\begin{matrix}\text{blocked}\\\text{clear}\end{matrix}\right\}$ indicator, electro-magnetic lock, a few sack cells and sundry connections. An imaginary case will best illustrate the idea. In fig. 6 a manual lever is depicted with the intention of showing its connection with the branch home (No. 4) on the bridge of signals sketched upon the same diagram. Some distance ahead, usually a long train length, the advance signal for the branch line may be noticed. Now it will be manifest that if under absolute block working a train is stopped at the advance semaphore, the signalman should not interfere with lever No. 4 controlling the junction home signal for the branch, otherwise two trains would have access to the same block section. Should an attempt be inadvertently made to get the lever over, the electric lock would render such an effort futile. Local circumstances determine the length of track, but it is customary to insulate about 60 or 80 yards of the rail metals, intermediate joints being suitably bonded to ensure the continuity of the circuit.

At the commencement of this insulated line a single gravity cell is connected to both rails, while at the remote end two covered wires are similarly connected, the opposite ends of which terminate at the relay terminals in the points box. When the line is clear, current from the gravity cell passes along one rail through the line wire and track relay and back to the battery along the second rail. While these conditions prevail the lever may be pulled off at any time, as the electric lock in the local circuit can be energised as soon as the lever latch is lifted. When, however, an engine or vehicle with metal wheels and axles is standing upon the insulated section, the gravity cell is short-circuited, the relay becomes inoperative and the local circuit is broken, thus locking the lever and preventing a wrong manipulation of the same. A track relay is more serviceable when fitted with a double tongue, each insulated from its neighbour, though both are actuated simultaneously from the same coil.

The advantage of such a detail must be evident at a glance, for an indicator can be connected locally to one side (showing whether the line is "blocked" or "clear") through one or two Leclanché cells, and the electric lock can be joined to the other tongue through four or five sack cells. On an English main line the average insulation resistance between metals measures 3·3 ohms per 880 yards of track, other distances to be calculated *pro rata*. The resistance of a gravity cell depends upon the condition of the zinc plates, their correct adjustment in the cell, and the quality of the solution. It is not surprising therefore that results varying between 0·999 and 6·5 ohms have been registered. Seeing that a battery is most effective when its internal resistance is equal to the external resistance of the circuit, it follows, as a corollary to these statements, that a low-resistance relay is eminently desirable for this class of work. In practice a 4 or 8 or 10 ohm relay has been found generally satisfactory. As regards the construction of a track battery, the glass portion might with advantage be dispensed with, as it is liable to crack should the electrolyte freeze in the depth of winter. A teak wood box smeared inside with marine glue will obviate the trouble. American engineers usually excavate ground pits alongside the track in which the battery is placed sufficiently deep to be below frost line; but when drainage troubles, &c., are encountered, it is a moot point whether a stoutly built, sawdust-lined battery box *above* ground is not cheaper and better; certainly the latter system is in vogue in certain parts of Lancashire, and the "freezing" difficulty has been surmounted.

Surprise may be expressed that reference has not hitherto been made to patent fog horns and similar inventions (their name is legion) which, if brought into requisition, would automatically perform "fogging" duty and eliminate the "human element" entirely. This phase of the subject scarcely comes within the purview of our article, but it may be taken for granted that the reason why these novel devices are so rarely accepted by railway boards is in consequence of their unadaptability to practical railway requirements.

REVIEWS.

L'Electricité a l'Exposition de Liége, 1905. By J. A. Montpellier. Paris: H. Dunod and E. Pinat. Price 18 fr.

This is a book containing nearly 500 pages, dealing with the various electrical exhibits at the Liége Exhibition of 1905. It is interesting to English readers, inasmuch as it describes, with drawings and photographs, types of machinery made by various Continental firms. The first part concerns itself with the production of electrical energy. Generators and engines are fully dealt with. A large number of pages and many beautiful illustrations are devoted to the transformer section.

In addition to the sections already indicated, there are chapters devoted to primary batteries, secondary batteries, electro-chemistry, electro-metallurgy (the descriptions and drawings of the furnaces are particularly good), electric lighting, measuring instruments, &c. The whole forms a very comprehensive account of the exhibits.

Etude de la Résonance des Systèmes d'Antennes dans la Télégraphie sans fils. By M. Camille Tissot. Paris: Gauthier-Villars.

This little work of 203 pages contains the chief results of experiments by Lieut. Tissot on resonance phenomena and wireless telegraphy obtained by means of the bolometer.

In the first portion the general conditions of resonance of certain systems of antennæ are studied. The second portion deals with the determination of the "periods" of systems, whilst damping is considered in the third part. Finally, the book concludes with a discussion of the various factors on which the transmission of wireless signals depends.

Besides the interest which the author's measurements possess for those engaged in actual practical work, throughout the book the results of theory and experiment are compared, so that there is quite a compendium of valuable information for the student.

Lieut. Tissot has produced a most interesting work, and freely uses throughout it the results of researches by Max Abraham, Macdonald, Drude, Bjerknes, and others.

In discussing damping the complete theory of Bjerknes on the "curve of resonance" is given. The equation to this curve, which is arrived at after a somewhat lengthy mathematical analysis, is:—

$$x^2 y - \text{A}\, x y - \text{B}\, x + \text{C}\, y + \text{D} = 0,$$

a curve of the third degree, where y is the energy brought into play, and x the periodic time.

It seems to the reviewer that there is a considerable amount of artificiality in this calculation, and taking into account the whole train of waves striking the receiver circuit, it is better to consider the "curve of resonance" as simply Gauss's "curve of error." This has already been pointed out in this country.

For instance, the probability curve may be written :—

$$y\, e^{h^2 x^2} = k,$$

or approximately

$$y\,(1 + h^2 x^2 + \&c.) = k$$
$$y + h^2 x^2 y + \&c. - k = 0,$$

where x and y have the same significance as in the equation above, and h and k are constants. This might be regarded as a curve of the third degree, which seemingly would fit the observed results. Of course, the above assumes "the law of error," and since the deviations in this case will be purely accidental, and not systematic, the assumption would probably satisfy even Prof. Poincaré. The maximum effect would be produced when the receiving circuit was tuned to respond to the average value of the waves in the other.

In this book also, there is the experiment with the bolometer, showing that the energy diminishes inversely as the square of the distance, so that the wave does not appear to be restricted in any way.

The "Electrician" Primers. Edited by W. R. Cooper, M.A., B.Sc. London: The *Electrician* Printing and Publishing Co. Price 10s. 6d. net.

These well-known primers have now been revised, and their number has been increased to 80. They can all be obtained in one volume, however, for the sum of 10s. 6d., and form by themselves a very handy reference library. We have found them very useful. Electrical applications are so varied that it is impossible to keep abreast of the times without occasionally refreshing one's knowledge. The standard, however, by which these primers must be judged is now much higher than when the earliest of them appeared, and, in our opinion, a more thorough revision would have been desirable.

On pp. 24-15 we read that the weight of a cubic foot of copper is 0·555 lb. at 60° F., but on the same page the weight per yard is given as 11·5625 A lb., where A is the area of the cross-section in square inches. In the first case, when only three significant figures are given, the temperature is carefully mentioned; but in the second case, when six figures are given, no mention is made of temperature. The formulæ obviously do not agree unless we suppose, which we admit to be highly probable, that 0·555 lb. is a misprint for 555 lb.

Again, on pp. 24-27 we see that 1 ft. lb. equals 13,562,000 ergs. The accuracy is somewhat delusive, as the latitude of the observer is not given. Sometimes an absurd number of figures is given. For instance, 26° Beaumé corresponds to a specific gravity of 1·21129, when the liquids are heavier than water. We are told that this is the specific gravity at 12·5° C., and that a knowledge of the values between 20° and 27° Beaumé is required for the acid for accumulators. Apparently the hydrometer can be read to the thousandth part of a degree.

In 12-3 for an explanation of the fundamental magnetic equation we read as follows: "For convenience in explanation it is best to take a coil of such shape as will give a uniform magnetic field, or a field having the same strength at every point. Such a uniform field is obtained by winding the wire round a wooden curtain ring, the field, of course, being inside the ring and the lines of force being circles concentric with the ring and forming, as it were, a sheaf in the same form as a ring."

This presents difficulties. The field of force is not uniform inside such a ring, even when we suppose that the pitch of the winding helix is zero. In practice there must be an appreciable field outside the ring. This probably sounds like heresy to most electricians, but if they consider a ring of only one turn, they will admit that it must be true. The comparison of the lines of force to a circular "sheaf" is a little puzzling to one familiar with harvesting operations. Ewing compares the lines of force linked with a circular current to a sheaf, and the simile is almost perfect; but to make a sheaf circular would be to spoil good corn. Doubtless we must agree to accept "wooden curtain rings," as "wooden anchor rings" have gone out of fashion since the Argonauts set sail to fetch the Golden Fleece. It is quite possible, however, that a wooden curtain ring does not convey any very definite notion to young electricians.

PRIMARY CELLS.

One hundred and six years ago the primary cell was discovered by Volta, and during the following 46 years gradual improvements were made without changing the principle of the original form. In 1842 Poggendorf devised the bichromate cell, and this form is still the most serviceable of the primary batteries. As a source of energy, however, its future commercial success must of necessity be very limited, due chiefly to the initial cost of the zinc electrodes, but also to the difficulties of manipulation. Many improvements might be made in the form of the cell, but even at its best the question of the zinc will always stand in its way. The principle of the depolarisation cell is simple. The source of the E.M.F. is a metal which must be electropositive in character. This on dissolving in an electrolyte drives the hydrogen to the opposite pole, at which place reduction sets in and the formation of a back E.M.F. is prevented. In this manner a potential difference is maintained at the expense of the dissolving metal. Of the possible electrodes the following list represents the E.M.F. set up on dissolving in sulphuric acid against hydrogen equal to zero :—

Magnesium ...	=	1·5 volt.	Iron ...	=	0·3 volt.
Aluminium ...	=	1·3 „	Nickel ...	=	0·2 „
Manganese ...	=	1·1 „	Lead ...	=	0·15 „
Zinc	=	0·8 „			

Of these magnesium could not be substituted for zinc from the point of view of expense alone, and need not be considered further. Aluminium also suffers from the question of cost, but apart from this it forms an amalgam which oxidises with extreme rapidity. Manganese in the metallic form is almost a curiosity, but rich iron alloys are on the market, and might be employed in a suitable apparatus. To test this point, cells were constructed with zinc, iron and manganese-iron electrodes, the latter containing 70 per cent. manganese. In each case bichromate of potash was employed as depolariser and dilute sulphuric acid as electrolyte. The E.M.F. set up in each case was zinc : iron : manganese-iron :: 11 : 7·5 : 6. From this it will be seen that the E.M.F. of the manganese-iron cell is still lower than that of the ordinary form, but it is an improvement on the iron electrode. In a run extending over 30 hours, a fairly steady current was obtained with a low resistance, and an almost constant E.M.F. was maintained throughout. If modified suitably, this might be employed, as, for example, in the new Edison accumulator.

Iron alone is now employed as a source of energy, but in a primary cell its efficiency in watt-hours per lb. weight is not as great as that of the lead accumulator. In addition to this, however, there is still the cost of material to be considered. Nickel also cannot be employed for the same reason. Lead is already employed in secondary cells, but for primary batteries its weight, low voltage in dissolving, and the insolubility of its salts all tell against it. At the present time, then, zinc is essential, and the problem resolves itself into one of manipulation and form of apparatus. Until quite recently the Leyland cell was the only one with any chance whatever of a commercial future. This consists of a zinc plate as the source of the E.M.F., and a copper-oxide depolariser. Weight for weight, this form has a watt-hour capacity far in excess of the lead accumulator, but like the latter the rate of discharge has to be kept within well defined limits. Its chief recommendation is its simplicity. Quite recently a modified form of the old bichromate cell has been introduced by F. A. Decker (*Electrical World*, Vol. XLVIII, No. 15), which promises to have some success. It is of the two-fluid type, but the internal resistance is reduced to a minimum by rubbing down the walls of the porous partition to a very small thickness. This porous cup is made rigid by strengthening ribs. The carbons are made of corrugated graphite, this form offering a large surface to the action of the depolariser. The zincs are of the usual

plate type, two being used to every three carbons. Each cell is contained in a hard rubber vessel provided with outlets through the bottom, and into the porous cups and the surrounding space. In this manner the fluids can be run in and out without taking the apparatus apart. The porous cups contain the dilute acid, and the surrounding space the bichromate of soda, and both are connected with a separate supply reservoir. A single cell of the above type has a discharging power of 250 watt-hours at an average of 1·684 volts, the complete weight being 17 lb., *i.e.*, 14·7 watt-hours per lb. weight, which is about twice as great as that of an accumulator of the same weight. If, however, a sufficient supply of liquid is carried to completely dissolve the zinc, then the output is increased to three times that of an accumulator of the same weight. The cost is 1s. 6d. per horse-power-hour. This latter consideration prohibits any extended use of this cell as a source of power, but where the cost is a secondary consideration, then it has many advantages over the lead accumulator.

The question now arises as to the possibilities of recovering the zinc and bichromate of soda. Such a cell would then become a secondary one in principle. Bichromates can be prepared from chrom-iron anodes in carbonate solutions, but the problem has not been solved for acid electrolytes, and, consequently, would not apply to the present case. Zinc also cannot be reduced from acid solutions, although it is possible in the absence of free acids. With some other electrolyte, and with another form of depolariser, the latter problem is by no means impossible. At the present time it is only an object to be aimed at.

SHIFT ENGINEERS.

By W. MAYALL MILNES.

II.—Duties and Qualifications.

Some shift engineers seem to consider their whole duty to consist of an occasional walk round the works to see that everybody is doing his work, and then go back to their office to have a smoke, and read the current issue of the Review.

Fortunately, this is not the conception the majority of men have of their duties.

The shift engineer is put in charge of the station, not only to see that the men under his supervision do their work, but that they do it intelligently, and with a view to obtaining the maximum of efficient economy.

His duties comprise the supervision of three distinct and entirely different departments, viz., the boiler house, the engine room and the switchboard. Each of these calls for unceasing attention on his part, and if properly looked after, will leave him very little time out of his eight-hour shift to spend in his office.

To begin with the boiler house, he must know by rote the position of every pipe, to what it is coupled, and its use, the locality and object of every valve and steam trap, &c. If the main steam range is on the duplicate or on the ring principle, he should have at his finger ends the different ways of getting steam through from the boilers to the engines, so that, in the event of a joint blowing out, or any other breakdown occurring on the range, he will know at once which is the quickest alternative means of getting through to the engine room by another path. Also he must know the different methods in vogue at his particular station of feeding the boilers, whether by a duplicate feed range or single range, and injectors as standby. He must look after his firemen, and see that they permit only sufficient water to pass to maintain as nearly as possible one water-level in the boilers, not at one time above and at another below the normal working level ; that the stokers are kept at a regular rate of feed, so as to maintain an even fire, and that they neither throw the coal too far, and so waste it by sending it into the pit before it is thoroughly burned, nor drop it all just inside the door ; that the fires are kept clean and bright all through, and are worked with as thick a fire as is consistent with the conditions of draught and class of coal used. He must keep an eye on the brickwork of the boilers and flues for cracks, and generally see that as little air as is possible is admitted to the flues, except through the fires ; in short, he must see that all efforts are made to obtain as great a percentage of CO_2 gases in the flues as possible. Where the station is fitted with a CO_2 recording apparatus, this will, of course, be much simplified, as the shift engineer can see at a glance exactly what percentage of CO_2 he has, and if it is low, at once proceed to locate the cause, and remedy it. He must see that the feed pumps are working properly, as it is most important that these should be kept in good working order, and any irregularities at once noted and attended to at the earliest opportunity.

In the engine room, one of the greatest sources of waste, if not systematically watched, is cylinder oil. When superheated steam is used, this item is very expensive, and even a gallon a day will mount up to a very considerable bill in a year's run. He should ascertain by experiment the exact number of drops per minute required for each cylinder, to keep the walls coated with a thin covering of lubricant, and see that they only get that number, as if more than enough oil is given to the engine, the surplus is simply carried away with the exhaust steam, doing no useful work. In fact, where the condenser discharge water is used for feeding the boilers, and not filtered, this oil will often do harm to the boiler shells. He must watch the vacuum, and if it falls below normal point, must immediately investigate the cause and remedy it, as the proportionate value of vacuum to an engine drops very rapidly when below 20 in. When engines are being loaded up, or load taken off them, their governing should be watched, to see that there is no excessive rise, or drop in speed. Also he should see that the dynamos and station motors are doing their work sparklessly and without undue heating of any of their parts. That all machinery is kept clean, and ornamental work bright. Dirt is an open invitation to hot bearings, and dust about the brush gear, and between the connections to the commutator, a frequent cause of sparking and bad commutation. It must be one of his duties to see that all arc lamps in the station receive proper attention from their attendant, so that they will always be ready for the evening's run.

With regard to the switchboard, his duties there will perhaps be the lightest. He must see that the attendant keeps the instruments, switches, &c., clean and in good order and keeps his voltage steady. If it is a growing station he should occasionally feel round the connections on the feeder board, to see that that they are ample to carry the maximum load without overheating, and report on them to the manager. He must check the log books periodically, to see that all records are properly entered up at the close of each day's run, and report any unusual records, such as excessive earth return currents, on the Board of Trade panel, if it be a traction station. If it is a lighting station, when the load is falling off, he must see that the generators are changed over : that is, as soon as the load drops sufficiently, a smaller machine must be put on, as machines are usually built to give their greatest efficiency at full load, and anything under that means an increased cost per unit generated.

In addition to this, the shift engineer should have under his supervision any small alterations carried out on the station, but not large extensions.

Some of these duties will only fall to the lot of the shift engineer once in three weeks, if three shifts are run, for instance, the checking of records, supervising alterations, &c., which of course the man on duty will attend to, but all should be carefully and systematically performed, if satisfactory results are to be obtained.

The next and last article of this series will deal with the position, privileges and remuneration of the shift engineer.

Electric Light Canvassing at Maidstone.—Mr. Oswald Jones has resigned the position of E.L. canvasser for Maidstone T.C. "on account of the continued opposition of other contractors and their friends." Mr. Jones is in business in the town as an electrical engineer, and his appointment was objected to when it was made, on the grounds that he was given a preference and was placed at an advantage which other traders did not possess.

A COMPARISON BETWEEN ARC LIGHTING AND HIGH-PRESSURE GAS LIGHTING FOR ROADS.

The following comparison between gas and electric lighting as employed in two of the main streets of Berlin has been worked out by Herr L. Block (*Journal für Gasbeleuchtung und Wasserversorgung* and *E.T.Z.*) The electrical installation is one consisting of ordinary 15-ampere arcs in opal globes erected in 1905 in the Friedrichstrasse. These lamps are in the middle of the roadway, 30 metres apart on the average, and are hung at a height of 10 metres. The high-pressure (millennium light) gas installation is one in use in the Alexanderstrasse, and consists of double-burner lanterns placed at the edge of the kerb alternately on the two sides of the road, 42 metres apart, and at a height of 5·7 metres. Each burner requires 600 litres of gas per hour, and this is supplied through special pipes in the form of ordinary lighting gas subjected to increased pressure in a special compressor. Figs. 1 and 2 show the curves of horizontal illumination, in the two cases respectively. These were taken along a line joining neighbouring lamps, and at a height of 1·5 metres from the ground. From these curves the illuminations at all points of the street have been obtained and are shown by means of variously shaded squares in figs. 3 and 4. The illumination at the centre of each square is marked in the square. The average of these various values gives the average horizontal illumination, and this average is 6·8 lux in the case of the Friedrichstrasse and 5·2 lux for the Alexanderstrasse. Since uniformity of lighting is also of import-

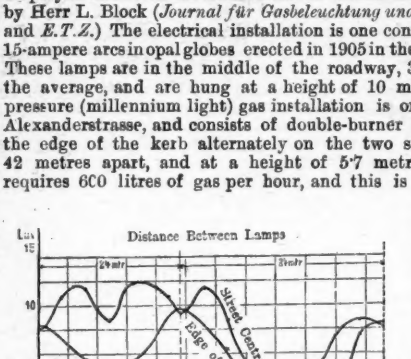


Fig. 1.—Lighting of the Friedrichstrasse with Electric Arc Lamps.

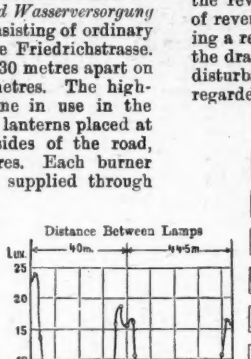


Fig. 2.—Lighting of the Alexanderstrasse with Millennium Gas Lamps.

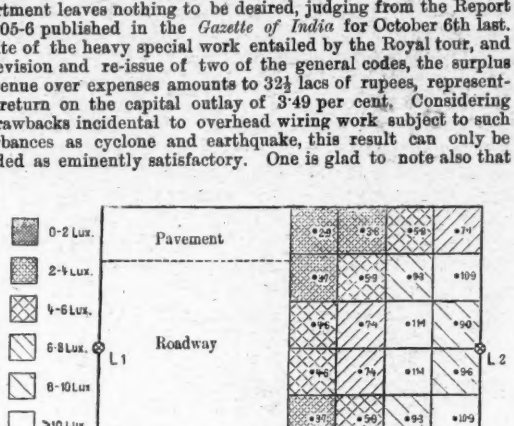


Fig. 3.—Lighting of the Friedrichstrasse.

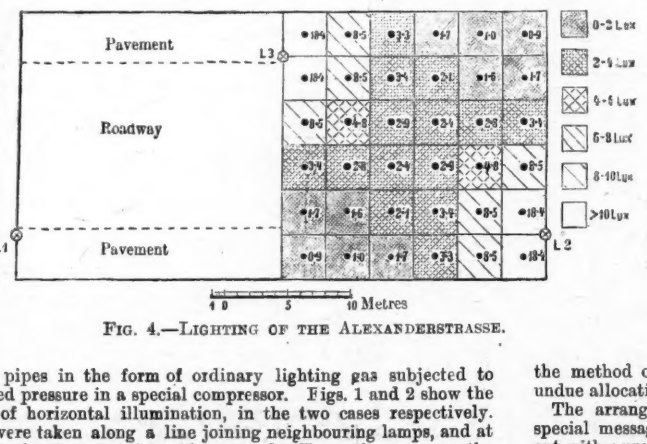


Fig. 4.—Lighting of the Alexanderstrasse.

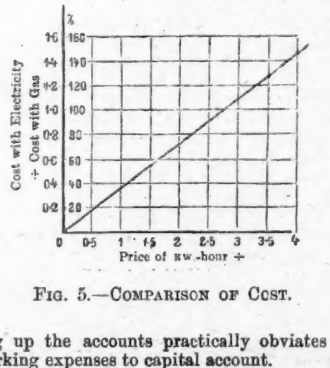


Fig. 5.—Comparison of Cost.

ance, it is interesting to note the ratio $\frac{\text{maximum illumination}}{\text{mean illumination}}$ = 1·63 for the electric light and 3·6 for the gas light, also the ratio $\frac{\text{minimum illumination}}{\text{mean illumination}}$, which is ·38 for the electric light and ·15 for the gas light, showing that the electrically lighted street is far more uniformly illuminated than the gas lighted one.

Leaving out of account the cost of attendance and upkeep, which do not differ much in the two cases, the number of watts to give an illumination of 1 lux over a road surface of 100 m². is

$$= \frac{15 \text{ amps.} \times 55 \text{ volts} \times 100 \text{ m}^2.}{6{\cdot}8 \text{ lux} \times 30 \text{ m.} \times 22 \text{ m.}} = 18{\cdot}4,$$

and the number of litres of gas consumed per hour for the same illumination is—

$$\frac{2 \times 600 \text{ litres per hour} \times 100 \text{ m}^2.}{5{\cdot}2 \text{ lux} \times 21 \text{ m.} \times 21 \text{ m.}} = 52.$$

In fig. 5 the curve connecting the relative cost of electrical energy for a given illumination / cost of gas for the same illumination with the relative cost of a kilowatt-hour / that of a cubic metre of gas is given. When 1 m³. (35 cb. ft.) of gas costs the same as 1 kw.-hour, the cost of electric lighting will be seen to be only about 36 per cent. of that of gas lighting. When the cost of 2·75 m³. (95 cb. ft.) is equal to that of 1 kw.-hour (*i.e.*, when 1,000 cb. ft. of gas cost 10½ times as much as a kw.-hour), the two methods of lighting become equally cheap

REPORT OF THE INDIAN TELEGRAPH DEPARTMENT FOR 1905-6.

In general features the administration of the Indian Telegraph Department leaves nothing to be desired, judging from the Report for 1905-6 published in the *Gazette of India* for October 6th last. In spite of the heavy special work entailed by the Royal tour, and the revision and re-issue of two of the general codes, the surplus of revenue over expenses amounts to 32½ lacs of rupees, representing a return on the capital outlay of 3·49 per cent. Considering the drawbacks incidental to overhead wiring work subject to such disturbances as cyclone and earthquake, this result can only be regarded as eminently satisfactory. One is glad to note also that the method of making up the accounts practically obviates any undue allocation of working expenses to capital account.

The arrangements for dealing with the heavy Press and other special messages in connection with the Royal visit were carried out with a promptitude which in itself is a certificate of the efficient working of the system. The extensions necessitated were, to a considerable extent, afterwards incorporated into the regular service. To strengthen the staff of existing offices and to open camp offices wherever required, a travelling staff was organised composed of telegraph masters and signallers well qualified in the Wheatstone system of automatic telegraphy, and placed under the charge of a traffic sub-assistant superintendent. Six clerks were attached to the staff, to assist in handling the apparatus which had to be carried by the travelling staff, and to do the general work of signal office peons. This staff was equipped with four portable sets of Wheatstone automatic apparatus and a supply of portable sounders for opening camp offices and wayside stations. A day prior to the departure of the Prince from Bombay, one of the parties proceeded to the place to be next visited to set up the automatic apparatus and to strengthen the staff at the telegraphic office there, while the other party remained in Bombay till the day after the departure of His Royal Highness, and proceeded to the second place to be visited. By this arrangement one party was kept always in advance setting up the Wheatstone instruments, &c., while the other dealt with the traffic at the camp of the Royal party.

The task of transmitting the long Press messages concerning the arrival of the Royal party fell to the Bombay office. The largest number of words tendered on any one day during the tour was on December 20th, at Gwalior, when 43,432 words were transmitted by the several correspondents.

During the voyage of the Royal party from Calcutta to Rangoon, and again from Rangoon to Madras, telegrams were exchanged by means of wireless telegraphy between H.M.S. *Terrible*, *Hyacinth* and *Renown*, and the land wireless telegraph stations at Sangor Island and Diamond Island. The greatest distance at which communication was maintained was 200 miles from Diamond Island with the *Hyacinth*, and 280 miles with the *Terrible*; the latter vessel reported that she was able to read signals from Port Blair at a distance of about 300 miles. The establishment of communication between Diamond Island and Port Blair was only completed on February 10th, 1905. The system was opened for public traffic on October 1st, 1905, and the traffic since then has averaged about 27,000 words a month.

Other items of interest to electricians are the laying of underground telegraph cables at Calcutta, being the first practical step towards putting the telegraph lines underground, the substitution of accumulators for primary batteries over a large part of the system, and the introduction of "club tickers" and Baudot long-distance type-printing instruments.

The underground cables mentioned were lead-sheathed and paper-insulated, each containing 20 conductors, and were laid in bitumen. Similar cable was used in Lahore and Simla as leads from the dynamo houses to the telegraph offices in connection with the substitution of accumulators for primary batteries. In Lahore the cable was put underground, while in Simla it was placed overhead. About 5½ miles of Henley's anti-induction 20-conductor cable was used in reconstructing a large portion of the Simla telephone exchange lines, the cable being suspended by means of leather hangers from a stranded 450 lb. steel wire.

The substitution of accumulators for primary batteries has been carried out at Allahabad, Karachi, Mandalay, Simla and other important stations. The chief point of interest is the abolition of the local battery and the re-designing of the local instruments, so as to permit of their being worked from a line battery of 100 volts. This has, naturally, led to measures being taken to replace any fittings likely to break down or involve fire risk through the increased voltage.

The "club-tickers" have been installed at Simla. One is rather surprised at the somewhat awestruck way in which the report regards these instruments, which are not precisely new discoveries.

With the Baudot instruments it has been found practicable to work duplex direct from Calcutta to Simla—a distance of 1,200 miles, using a copper wire. It is believed that this distance is a record performance for direct work with the Baudot system.

Finally, we have an exhaustive list of interruptions, which, however, would be the better for rather more minute classification. As set forth, the tendency is rather to lump the good with the bad and so produce a medium. The number of interruptions on the departmental lines during the year were 4,172, with a total time of 56,982 hours, or about 14 hours each. We are not informed what proportion is attributable to the telephone service, which is, generally speaking, more liable to interruption than the telegraph. It would also be fairer to the department if breakdowns were classified under two headings, namely, those occurring in districts where the line and repair appliances were both easily accessible, and those taking place in the sparsely inhabited mountainous and forest districts, or other difficult country. Earthquake and cyclone, we learn, were responsible for 485 interruptions, or about one-eighth of the whole. The disorganisation caused by these extensive catastrophes would naturally delay the repairing operations and cause the duration of the interruption to be disproportionately long compared to one caused by a fallen tree, for instance. This latter appears to be a very fruitful cause of interruption, as 327 are ascribed to it. Birds and animals have 693 against them, and "malice" 133. These last are principally due to a most civilised desire for copper amongst the barbarians of Wazinstan and Baluchistan. "Unknown" causes, and "other unpreventable causes" have assigned to them 1,489 interruptions, more than one-third of the total, with a duration of 17,000 hours. The attention of divisional superintendents has been drawn to the former, and it is hoped to diminish the proportion by stricter control.

The cost per message to the department is given as ·859 rupee (working expenses). The decrease in cost for the past four years has been steady, though not very rapid.

THE SUDDEN SHORT-CIRCUITING OF THREE-PHASE ALTERNATORS.*

Since occasional short-circuits are almost unavoidable, especially in power transmissions and in connection with chemical work, it has become the custom, at least in America, to specify that an alternator shall be able to carry its short-circuit current for a short time without damage. Many cases have, nevertheless, occurred in which heavy damage to the machine has resulted from a short-circuit. The coil ends are sometimes bent out of shape by the enormous forces set up, and, even when visible deformation does not take place, sufficient motion to damage the micanite insulating tubes often occurs. It is, therefore, of considerable practical importance to investigate the exact occurrences at the first instant of the short-circuit, because it is then that the chief damage is produced—after the first instant the short-circuited machine is practically running unloaded owing to the large phase displacement between volts and amperes.

By means of an approximate mathematical investigation, Mr. Punga arrives at the following conclusions, some of which he has been able to confirm experimentally.

Let M_o = the normal flux entering the armature from one pole,

F = field ampere-turns per pole required to set up normal full-load current on short-circuit.

When this short-circuit current is flowing a small flux M_f still enters the armature in order to compensate for the armature self-induction. The flux in the magnets at the same time is $M_f + M_f$ where M_f is the magnet leakage flux.

If F_o = normal excitation ampere-turns, the short-circuit current with this excitation will be $\frac{F_o}{F}$ times the normal full-load current. The flux entering the armature will be $M_{\infty} = M_o \frac{F_o}{F}$, and the leakage flux from the poles = $M_{f_o} = M_f \times \frac{F_o}{F}$. A sudden short-circuit when running under normal conditions, therefore, involves a reduction in flux, both in the armature and in the poles, of $M_o - M_{\infty}$ lines, and it is this variation which produces the

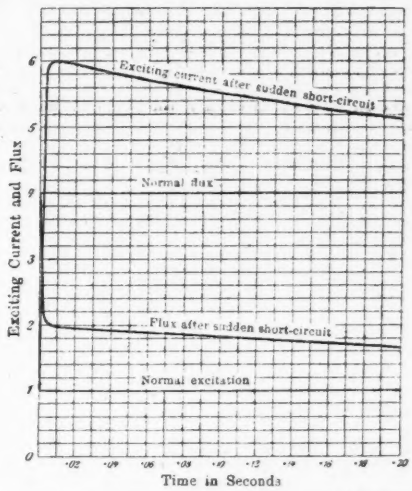


Fig. 1.—Values of Exciting Current and Magnetic Flux after Sudden Short-Circuit.

abnormal results noticed. This large change of flux cannot, of course, occur instantaneously, and during the whole transition period a voltage is induced in the armature in excess of that required to pass the normal (steady) short-circuit current. At the very first instant this voltage is $\frac{M_o}{M_{\infty}}$ times as great as the normal, and if the short-circuit current could rise instantaneously, its value at the first instant would be $\frac{M_o}{M_{\infty}}$ times the steady value. Actually, however, the flux must have fallen somewhat from its maximum value before the short-circuit current can rise, so that the maximum short-circuit current is always somewhat less than $\frac{M_o}{M_{\infty}}$ times the steady value. Now the value of $\frac{M_o}{M_{\infty}}$ varies with the design of the machine and its size between about three and six, and is usually greater the greater the flux per pole. Considering that the steady short-circuit current is usually 2½ to 3½ times the normal full-load current, the short-circuit current at

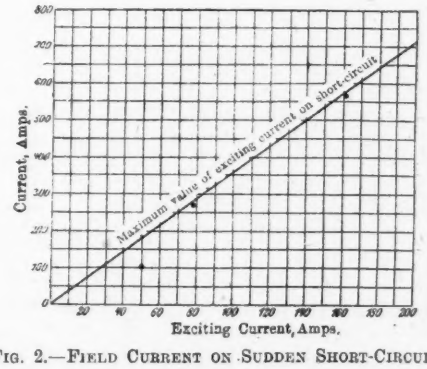


Fig. 2.—Field Current on Sudden Short-Circuit.

the first instant may, as a limiting value, attain to 20 times the normal full-load current. Such a current could, of course, exert excessive mechanical forces on the windings, because the forces increase as the square of the current. The above actions are complicated by the facts that—

1. The heavy armature currents themselves tend to accelerate the fall in flux from M_o to M_{∞}; and

2. The rapid fall in flux looped with the field winding sets up a voltage in the field winding tending to increase the exciting current.

After investigating these effects, the author comes to the conclusion that the short-circuit current reaches its maximum value

* Abstract of an article by F. Punga in *Electrotechnische Zeitschrift*.

within a quarter period after the occurrence of the short-circuit, that this value is $\frac{M_o}{M_f + M_s}$ times the normal full-load current, and that it then falls to the steady value in accordance with a logarithmic law. Also that the maximum momentary value reached by the exciting current is $\frac{M_o}{M_f + M_s} \frac{F}{Z} + i_o$ (where Z = field-turns per pole, and i_o = normal exciting current), and that this also falls to the normal value along a logarithmic curve. The shapes of the curves connecting (1) flux and (2) exciting current with time, are shown in fig. 1 for a 50-cycle alternator. It will be seen that the abnormally high rate of change of flux only occurs during the first ¼ period.

The writer also points out that in case the short circuit contains appreciable resistance, a momentary increase in torque occurs, which may amount to two or three times the normal, and may produce a dangerous mechanical shock to the machine. Some tests made by Mr. Hobart and the author on a 5,000-K.V.A. Siemens-Schuckert alternator tend to confirm the theory put forward. The machine had 20 poles, and the normal flux per pole was 15,200. The flux to

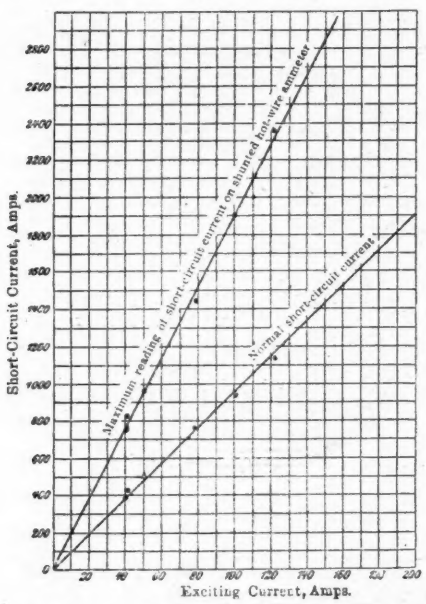


Fig. 3.—Armature Current on Sudden Short Circuit.

compensate for armature self-induction was estimated at M_s = 750 lines. The ampere-turns required to pass the normal full load current on short circuit were found by test to be 4,800 = F. These ampere-turns produced a leakage flux from pole to pole (M_f) estimated* at 1,400 lines. Therefore $M_f + M_s$ = 1,400 + 750 = 2,150 lines. There were 63 field turns per pole, and the normal exciting current was 185 amperes.

By the formulæ given above, the maximum value to which the exciting current should rise on the occurrence of a sudden short circuit = 185 + $(\frac{15200}{2150} \times \frac{4800}{63})$ = 725 amperes.

Fig. 2 shows the test results obtained when the alternator was short-circuited at various excitations, and the rise in exciting current was measured with a Deprez d'Arsonval instrument. It will be seen that with an original excitation of 185 amperes, the maximum reached was 650 amperes, or only slightly below the theoretical value.

By the formula again the maximum value of the short-circuit current should be $\frac{15200}{2150}$ × normal full-load current = about seven times the normal full-load current. On test (as shown in fig. 3) the maximum instantaneous short-circuit current was only double the steady short-circuit current, or 4·9 times the normal full-load current, instead of seven times this value. This difference is largely accounted for by the inertia of the hot-wire instrument employed.

From these and other tests that were made, it is clear that very heavy forces may have to be withstood at the instant of short circuit, and where short circuits are liable to occur, special precautions as to the support of the coil ends and the micanite tubes must be taken.

Another point brought out is the excessive overload thrown on the exciters and the consequent danger of loss of field in these machines. On this account it is advisable to work with the minimum amount of brush lead and with the strongest possible exciter field, *i.e.*, to regulate the alternator voltage by a resistance in series with the alternator field rather than by varying the exciter shunt current.

* The armature self-induction and the field leakage were calculated by the formulæ given in "A Contribution to the Theory of the Regulation of Alternators," by H. M. Hobart and F. Punga. American Institute of Electrical Engineers. 1904.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

27,444. "Improvements in and relating to percussion, electric or like ignition tubes and the like for use with artillery and similar ordnance." H. Hale. December 3rd.

27,445. "Improvements in electrical contracts." I. H. Parsons and A. E. J. Ball. December 3rd.

27,459. "Permeated electric arc lamp carbons and electric incandescent arc lamp filaments." B. Johnson and J. Willis. December 3rd.

27,492. "Improved glass of lens for acetylene or electric lamps for vehicles and like purposes." J. G. Cockburn. December 3rd.

27,499. "Improved manufacture of dynamo brushes, sliding contacts or the like from carbon." Gebruder Siemens & Co. December 3rd. (Date applied for under Patents Act, 1901, February 16th, 1906, being date of application in Germany.) (Complete.)

27,520. "Improvements relating to the control of multiphase motors. Kalman v. Kando. December 3rd.

27,543. "Device for the protection of life on vehicular traffic such as motor cars, steam cars, and electric cars." R. Rosendorf, F. Jelinek, and L. Schleisinger. December 4th.

27,556. "Improved electric plug and resistance lamp." R. B. Choulер December 4th.

27,569. "Improvements in electric arc lamps." O. Gross. December 4th.

27,570. "Improvements in magneto-electric generators for ignition in internal combustion motors." Albion Motor Car Co., Ltd., and T. B. Murray. December 4th.

27,593. "Electrical communication between guard and driver, warning them of the opening of doors whilst in transit." H. Crepin. December 4th.

27,601. "Improvement in incandescent arc lamps." J. A. Prediger. (Date applied for under Patents Act, 1901, December 4th, 1905, being date of application in Germany.) December 4th. (Complete.)

27,603. "Improved electrical test lamp." J. B. Garty. December 4th.

27,623. "Improvements in electric meters." C. E. Holmes. (Date applied for under Patents Act, 1901, December 6th, 1905, being date of application in United States.) December 4th. (Complete.)

27,640. "Improvements in electric arc lamps." The New Century Arc Light Co., Ltd., and H. Baggett. December 4th. (Complete.)

27,683. "Apparatus for the calculation of the correct size of cables or wires used for the transmission of electric power, or for the solution of similar mathematical problems." A. P. Ackery. December 5th.

27,684. "Electric time switch." O. A. Bruun. (Date applied for under Patents Act, 1901, March 29th, 1906, being date of application in Denmark.) December 5th. (Complete.)

27,694. "Improvements in brush gear of dynamo-electric machines and motors." W. R. V. Marshall. December 5th.

27,714. "Improvements in electrical clocks." Aktiebolaget Svenska Elektriska Urfabriken. Date applied for under Patents Act, 1901, December 6th, 1905, being date of application in Sweden.) December 5th. (Complete.)

27,725. "Improved double-carbon electric arc lamp having inclined carbon holders." J. Brockie. December 5th.

27,726. "Improvements in electric arc lamps having mutually inclined carbon holders." J. Brockie. December 5th.

27,728. "Improvements relating to points or switches for electric tramways working upon the slot conduit system." M. O. Spicknall and J. G. White and Co., Ltd. December 5th.

27,736. "Improvements in or connected with electric motors." H. Leitner December 5th.

27,740. "Improvements in the electrolytic refining of copper." S. O. Cowper-Coles. December 5th.

27,745 "Improved electric magnetic device for detecting feeble impulses." The Helis Cell and Accumulator Co., Ltd., and G. Schauli. December 5th.

27,749. "Improved electric metallic separator." C. Lillicrap. December 6th.

27,762. "Improvements in and relating to the ventilation of cooling of dynamo-electric machines." W. Armistead. December 6th.

27,765. "Improvements in and relating to percussion, electric or like ignition tubes and the like for use with artillery and similar ordnance." H. Hale. December 6th.

27,813. "Improvements in the method of and means for operating electric pumps and the like." A. J. Cuming. December 6th.

27,841. "Improvements in low-tension ignition systems for internal combustion engines." Sir C. S. Forbes. December 6th.

27,856. "Improved means for producing high-voltage spark from low-voltage source." W. H. Clegg. December 7th.

27,859. "Improvements in the manufacture of electric incandescent lamps." O. Oberlander. December 7th.

27,861. "Improvements in and relating to dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 7th.

27,934. "Improvements in electric resistances." R. von Brockdorff. (Date applied for under Patents Act, 1901, December 8th, 1905, being date of application in Germany.) December 7th. (Complete.)

27,957. "Improvements relating to sparking plugs." E. Moonen and A. Dumaire. (Date applied for under Patents Act, 1901, December 9th, 1905, being date of application in France.) December 7th. (Complete.)

27,950. "Improvements in and relating to the control of electric generators." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 7th.

27,956. "Improvements in transmitting apparatus for wireless telegraphy." P. O. Pedersen. (Date applied for under Patents Act, 1901, December 8th, 1905, being date of application in Denmark.) December 7th. (Complete.)

28,015. "Vent valves for batteries." F. J. Schalow. December 8th. (Complete.)

28,034. "Improvements in dynamo construction." H. Leitner. December 8th.

28,037. "Improvements relating to dynamo-electric machines." C. E. Bonine. (Date applied for under Patents Act, 1901, December 29th, 1905, being date of application in United States.) December 8th. (Complete.)

28,048. "Self-regulating load-resistance for comparing current tension and power." M. Kallmann. (Date applied for under Patents Act, 1901, July 5th, 1906, being date of application in Germany.) December 8th. (Complete.)

28,049. "Device for comparing current tension and power by means of self-regulating load-resistances." M. Kallmann. (Date applied for under Patents Act, 1901, May 17th, 1906, being date of application in Germany.) December 8th. (Complete.)